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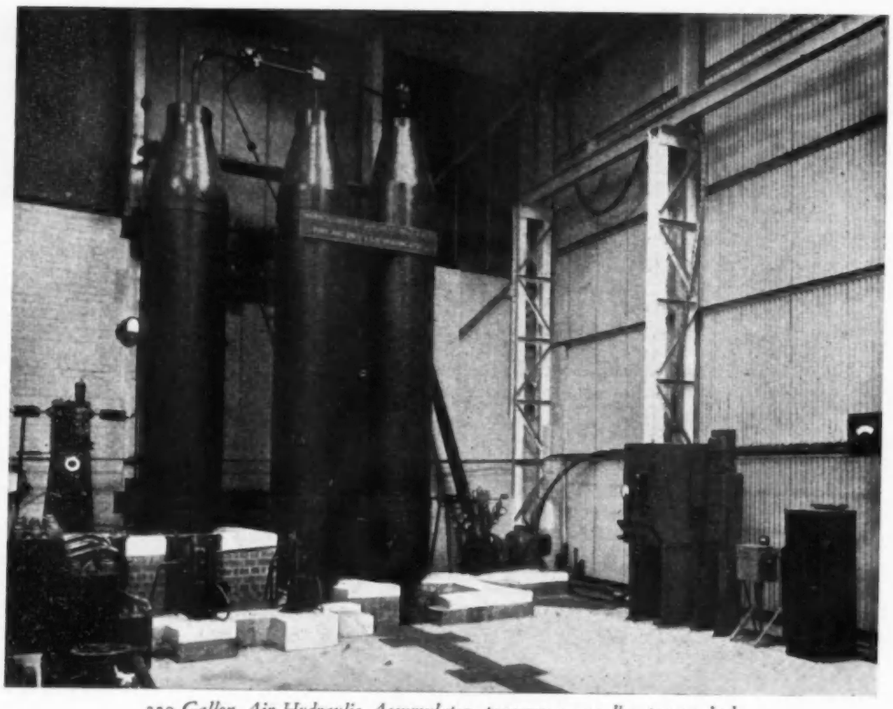

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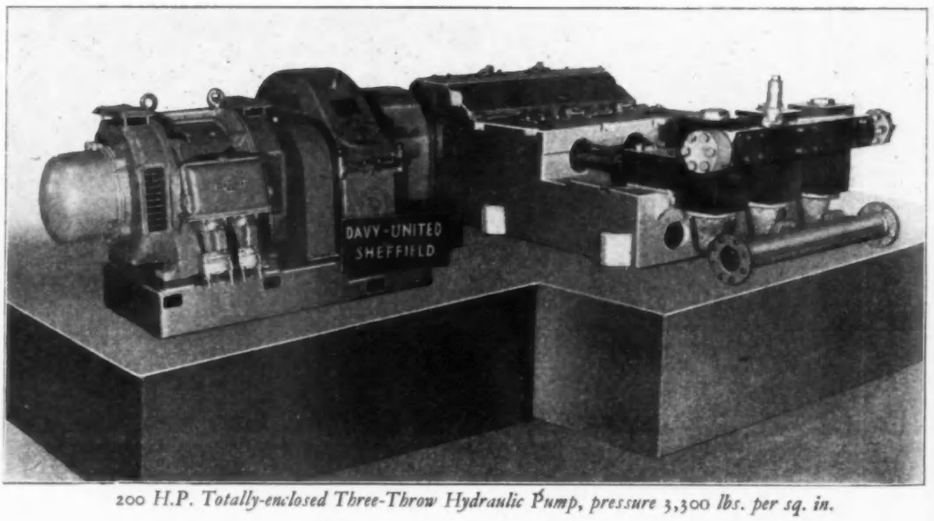

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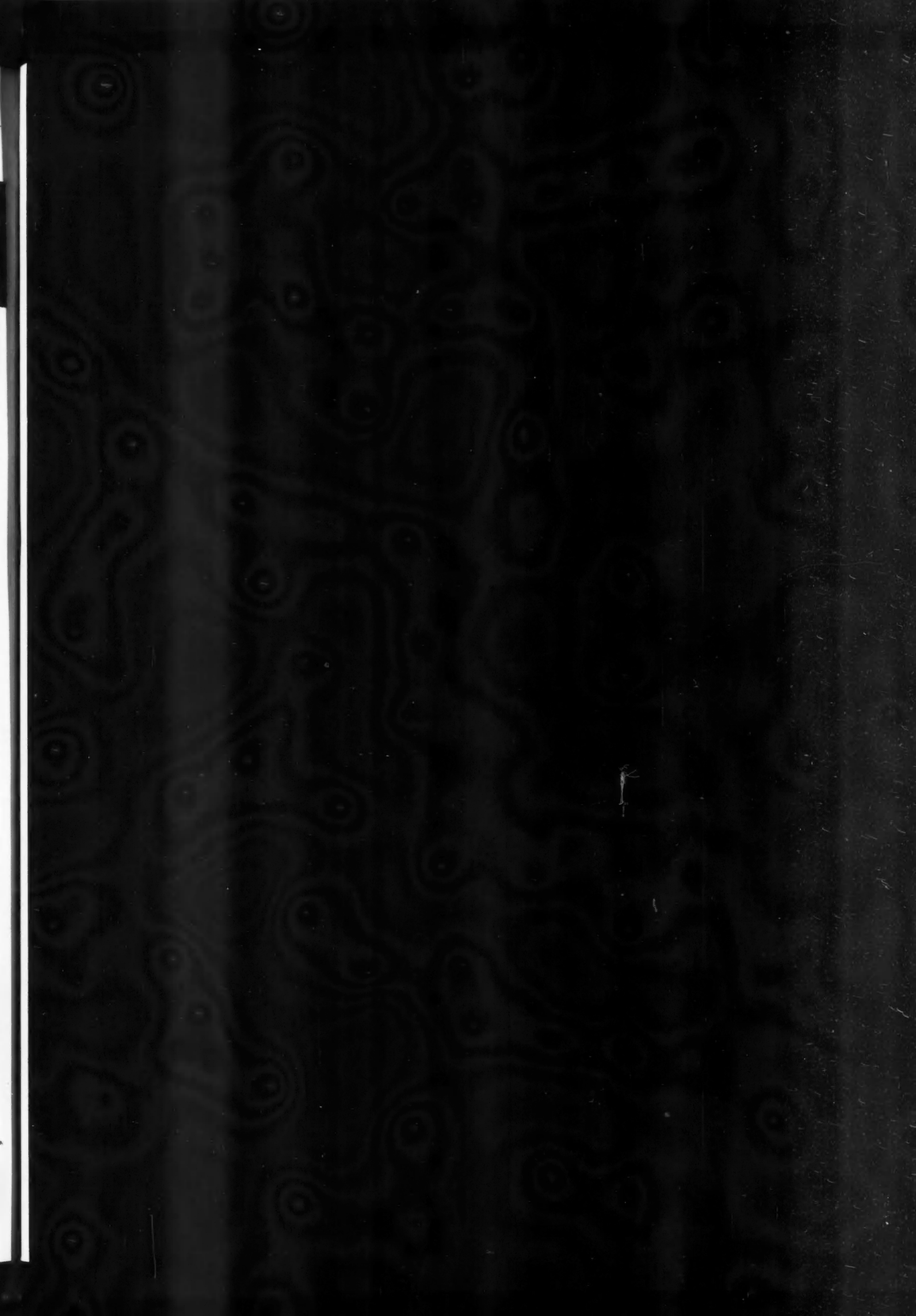


THE DISTRIBUTION OF VELOCITY WITHIN A NEST OF TUBES.

By R. PENDENNIS WALLIS, Ph.D., M.Inst.C.E., M.I.Mech.E.

(*Concluded from page* 362.)

Transverse Velocity Distribution.—While the longitudinal velocity distribution was obtained with the relatively simple sledge Pitot-static tube, more extended search had to be made for suitable total energy and static pressure tubes for the transverse traverse. With regard to the pressure representing the total energy of the stream it will be seen from Fig. 1, on page 361, *ante*, that opposite the gap between any pair of tubes the stream is always in the downstream direction; whereas on the centre line of the tube the time average of the velocity, which it is desired to record, will be in the upstream direction. The Pitot tube shown in Fig. 11 was therefore designed so that the pressure hole could face upstream or downstream while being traversed across a section midway between the first and second rows of tubes. The Pitot tube took the form of a plain cylindrical tube with a small radial hole drilled about 2 cm. from its closed end. The tube could be moved up and down by means of a micrometer and rotated through any angle by means of a protractor as illustrated in Fig. 1 of the previous work.* The tube was kinked backwards so that the vertical diameter of the pressure hole was on the vertical axis of the Pitot tube and remained stationary when the Pitot tube was revolved. Theoretically† in an inviscid fluid the pressure excess at the upstream generator of such a cylindrical tube is $\frac{1}{2}\rho V^2$ (where ρ is the density of the fluid and V the velocity of the stream) and the corresponding recorded pressure represents the total energy of the stream. In actual fluids the effect of viscosity is to increase this pressure but experiments by Thom‡ show that, provided the Reynolds number based on the Pitot tube diameter exceeds 100, as it did in the present work, there should be no detectable deviation.

Fig. 11.

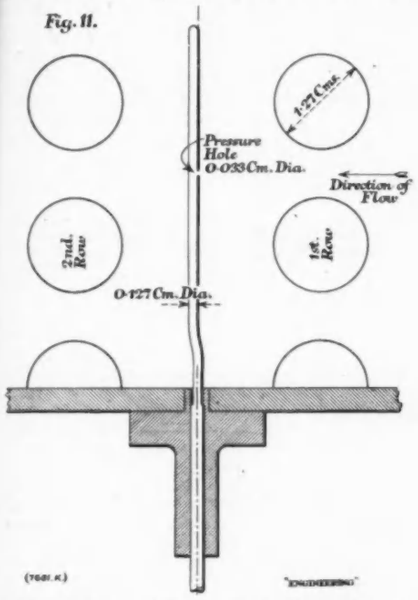
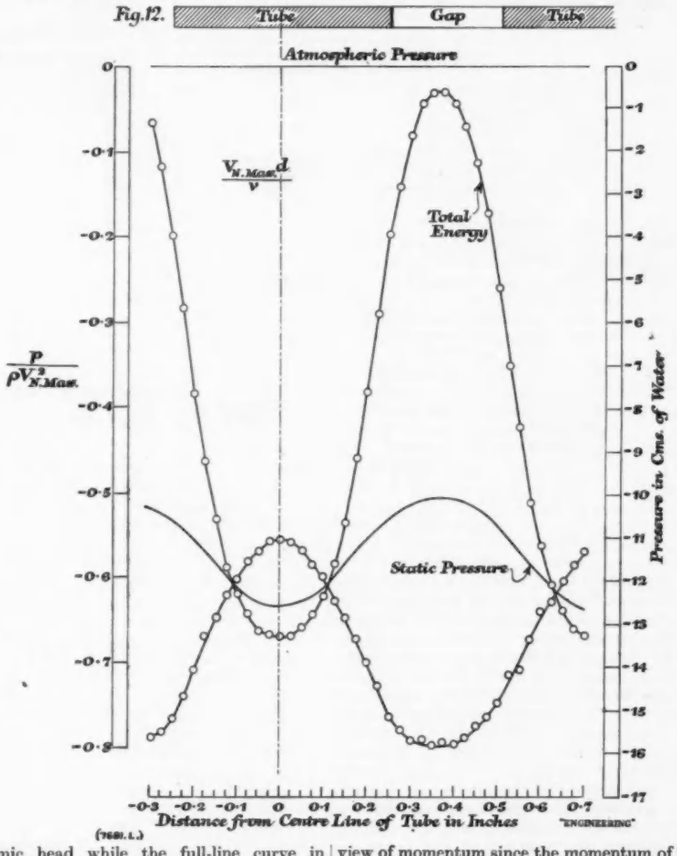


Fig. 12 shows the pressure recorded with this Pitot tube with the pressure hole facing upstream and also with it facing directly downstream. The static pressure, separately determined, enables these readings to be used to give the relevant velocities whether these are downstream as in the jet or upstream as in parts of the eddies. A further inspection of Fig. 1 will reveal something of the difficulty of designing a pressure tube to measure the static pressure between the first and second rows of tubes. However, it was realised that away from the ends of the tubes in the nest the flow was two dimensional and that at any one instant the same shaped eddy existed for a considerable length of the tube. Therefore the type of static tube that was required was a thin disc in the plane of the eddy with the vertical diameter of the pressure hole traversing the same line as did the vertical diameter of the pressure hole of the Pitot tube. Such a static tube was made from a drawing pin head and is shown in Figs. 14 and 15, page 402. This static pressure tube was calibrated in a wind tunnel and was found to indicate a pressure lower than the true static pressure by 1·6 per cent. of the velocity head, $\frac{1}{2}\rho V^2$, of the wind stream. The static pressure as indicated with this tube is shown in Fig. 13 and, after applying the above small correction, has been added to Fig. 12. Fig. 16 shows

Fig. 12.



the dynamic head while the full-line curve in Fig. 17 shows the velocity distribution calculated from the dynamic head curve. When discussing the readings of the sledge Pitot tube used in obtaining the longitudinal velocity distribution it was stated that, in steep velocity gradients, the pressure indicated by the manometer tube was not that at the geometrical centre of the pressure hole, but that at a point a slight distance from the geometrical centre towards the region of higher pressure. An experiment was therefore made to determine the extent of this lateral "shift" of the total pressure curve. A model of the Pitot tube shown in Fig. 11 was made to a scale of five times the size. The velocity distribution across the diameter of a jet of air 2 cm. in diameter was determined firstly with a small standard Pitot tube and secondly with the enlarged model of the cylindrical Pitot tube. The velocity distribution was determined at distances of 3 cm. and 6 cm. from the face of the nozzle. These curves were plotted together with the true velocity distribution and the extent of the lateral shift thus determined. One fifth of this amount represented the appropriate correction and is shown by the broken line in Fig. 17. It is seen that the maximum velocity is slightly less than $V_{N.Max.}$ while the maximum upstream velocity in the eddy is nearly 0·4 $V_{N.Max.}$. The curve when integrated gives a mean velocity of 1,390 cm. per second or 3 per cent. greater than the entering velocity V_0; this result can be considered to be within the accuracy of the experiments.

The motion of fluid acted upon by external forces can be considered from two points of view: change in energy or change in momentum. Useful information can often be obtained by equating the work done on the mass of the fluid to the increase in its potential, pressure and kinetic energy. This method is successful when the eddy or other local motions are small, but in many practical engineering problems this is not so and it is difficult or impossible to assess the kinetic energy possessed by the eddies since their number, size and position are continuously changing. In such cases the motion can be more simply considered directly from the point of view of momentum since the momentum of the fluid in a stationary eddy is zero and the momentum of a moving eddy is that due to the translation of an equal mass of non-rotating fluid. According to Prandtl's momentum transport theory* the shear stress between two portions of a fluid moving in a parallel direction but with different velocities can be considered to be due to a portion of the fluid being transported bodily from one stream to the other through a distance l, which is called the "*mischungsweg*" or mixing length, and then imparting to the second stream its excess of momentum. With reference to Fig. 18, in which the velocity at A is u and that at B is $u + l\frac{du}{dy}$, the backward drag on B or the forward drag on A is equal to the mass interchange between A and B multiplied by the acceleration of this mass. The pair of unbalanced forces may be regarded as equivalent to

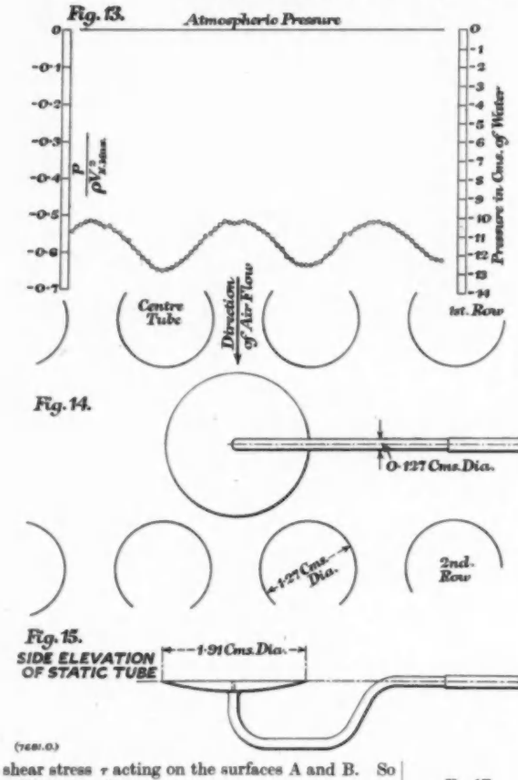
* Pendennis Wallis and Masey White, (1938), *loc. cit.*

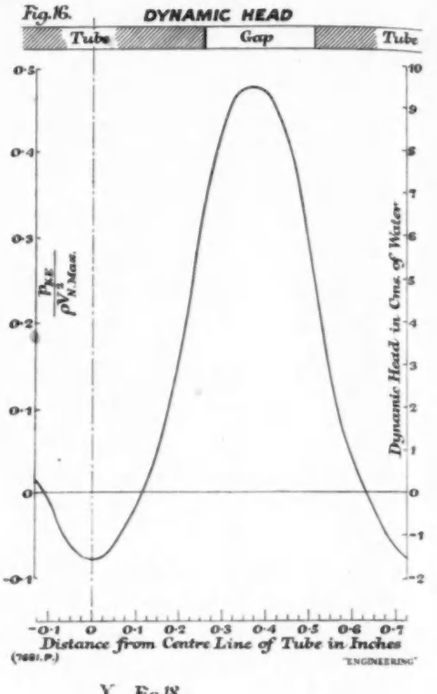
† Glaubert, H., *The Elements of Aerofoil and Airscrew Theory*, page 31. University Press, Cambridge (1930).

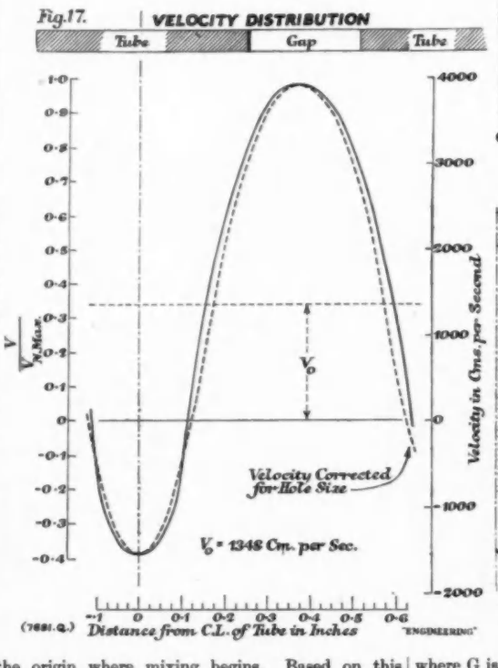
‡ Thom, A., *Reports and Memoranda of the Aeronautical Research Committee*, No. 1194, page 183 (1928).

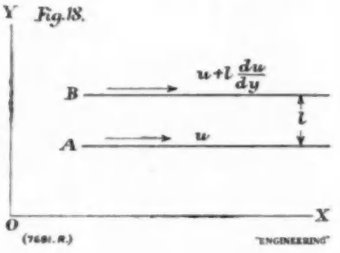
* Prandtl, L., *Zeit. für angewandte Math. u. Mech.*, vol. 5, page 136 (1925).

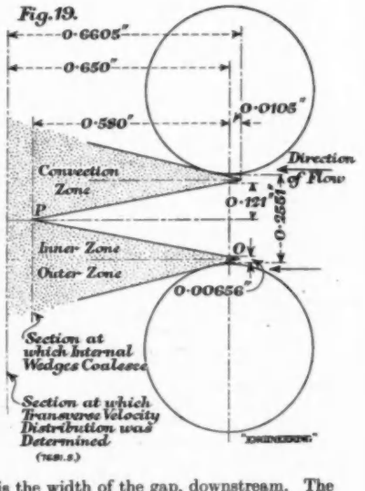
DISTRIBUTION OF VELOCITY IN A NEST OF TUBES.











a shear stress τ acting on the surfaces A and B. So considering unit areas :—

Shear stress τ = Mass interchanged per second between A and B × Change of velocity per second between A and B

$$= \rho l \frac{du}{dy} \times l \frac{du}{dy}$$

$$= \rho l^2 \left(\frac{du}{dy}\right)^2.$$

In this expression l is unknown, no satisfactory theoretical value for it having yet been derived, so recourse must be made to experimental values of which a number is known for various flow conditions.

Tollmien* has applied the formula to the mixing zones of a jet issuing into a still fluid of unlimited extent and deduced both the longitudinal and transverse velocity distributions. He considered two cases of two dimensional flow :—Case (1) the mixing of two streams of infinite width but of different velocities ; and case (2) a stream of fluid issuing from a narrow slit of infinite length. According to experiments, the width of the convection or mixing zone increases in direct proportion with the distance x from the nozzle and the transverse velocity distribution curves at various distances x possess definite geometrical relations. This is explicable on the assumption that the mixing length l is constant over any one transverse section and is directly proportional to x, *i.e.*, $l = c\,x$, where c is a constant. On this basis, Tollmien shows that for his case (1) the mixing zone spreads out downstream in direct proportion to the distance from the origin O in Fig. 19, and that the streamline which passes through the origin remains straight and is inclined outwards at a very small angle. The mixing zone is wedge-shaped, but is not symmetrical about the axis of x, the divergence of the inner portion being half that of the outer portion. The numerical value of these angles involves one experimental coefficient which, from wind tunnel measurements at Göttingen, is $\frac{l}{x} = c = 0{\cdot}0174$, where x is the distance downstream from the origin where mixing begins. Based on this value, the breadths of the inner and outer zones are $0{\cdot}085\,x$ and $0{\cdot}170\,x$, respectively ; while the streamline through the origin is inclined at an angle of 0·92 deg. outwards towards the dead-water region.

With regard to the value of the coefficient c, this, in the present case, is most readily determined from the location of the point P in Figs. 4 and 19, where the mixing zone originating on one side of the stream meets that originating on the other side. The point P is clearly defined from the longitudinal total energy distribution, Fig. 4, and is 2·27 G, where G is the width of the gap, downstream. The origin for the mixing zone is somewhat indefinite since a boundary layer already exists at the gap. There will not be much error if the mixing zone in the gap be assumed to be already as wide as the boundary layer at that point, viz., 0·0257 G. The internal wedge angle is therefore $\tan^{-1}\frac{(0{\cdot}5 - 0{\cdot}0257)\,G}{2{\cdot}270\,G}$ $= \tan^{-1} 0{\cdot}209 = 11$ deg. 48 min. Tollmien deduces that the tangent of this internal wedge angle is $\sqrt[3]{2c^2}$: thus in the present experiments $\sqrt[3]{2c^2} = 0{\cdot}209$, $2c^2 = 0{\cdot}00913$, and $c = 0{\cdot}0681$. In com-

* Tollmien, W., *Zeit. für angewandte Math. u. Mech.*, vol. 6, page 468 (1926).

DISTRIBUTION OF VELOCITY IN A NEST OF TUBES.

Fig. 20.

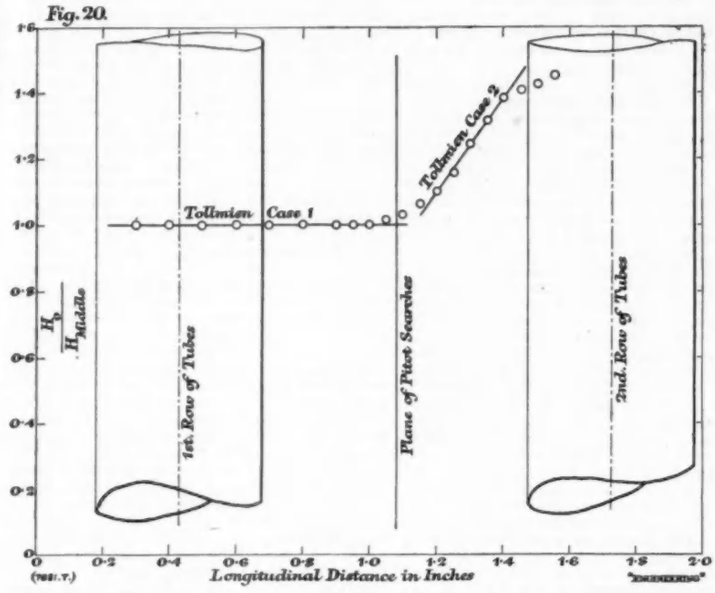
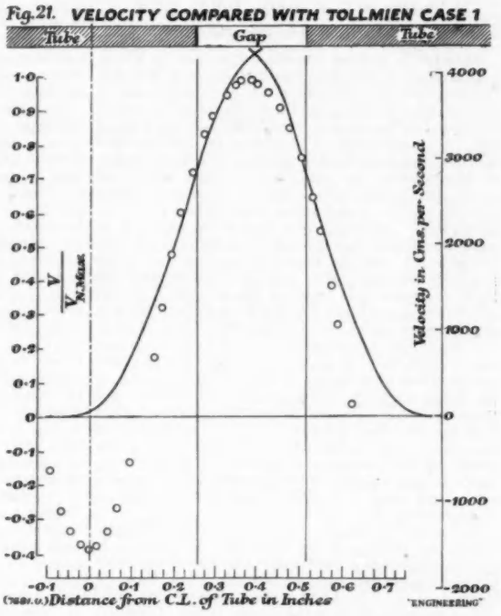


Fig. 21. VELOCITY COMPARED WITH TOLLMIEN CASE 1



parison with Tollmien's results, the mixing length in the nest is approximately four times as great, due no doubt to the large disturbances existing in the dead-water region at the rear of the tubes.

In Fig. 20, the ratio of the total energy in the original stream H_0 divided by the total energy along the centre line of the gap has been plotted. From this it is seen that the transverse velocity distribution shown in Fig. 17 was taken at a section where the flow is just changing from Tollmien's first case of a homogeneous air stream issuing into air at rest to that of his second case of a spreading stream issuing from a narrow slip. Actually the present problem approximates far more closely to the first one, since it is only at the centre of the jet that interference from the two sides can have taken place. Tollmien's second case is in fact developed on the basis of an infinitely narrow jet, or, alternatively, for infinitely great distance from a slit of finite dimensions; for this reason, the second case can hardly be expected to apply.

The transverse velocity distribution at the section midway between the first and second rows of tubes has, therefore, been compared with Tollmien's case (1). Using the above value of 0·0681 for the coefficient c, the velocity distribution according to Tollmien is shown by the full-line curve in Fig. 21, while the test points give the observed velocities after correction for Pitot tube shift. It will be seen that over the inner part of the jet there is very satisfactory agreement, except near the centre line, where the observed velocities are low in comparison with the theory. Here a difference is to be expected because the two mixing zones have already coalesced and the central filaments are subjected to the effects of mixing from both sides. The slight lack of symmetry noticeable in the figure is without significance and represents a displacement of only 0·02 cm. Towards the outer edges of the jet there is naturally a considerable discrepancy between the Tollmien curve and the experimental points; this is due to the fact that the theory is based on the assumption that the jet issues into a quiescent fluid of unlimited extent. The negative velocities and the turbulence in the dead-water region have no counterpart in the theory. It is thus seen that the fluid in the dead-water regions is set in motion by the jets issuing from the gaps of the preceding row of tubes and that the velocity distribution in the convection zones between the jet and the dead water is in agreement with the mathematical predictions of Tollmien, the mixing length being several times as great as that of a jet issuing into still air.

LITERATURE.

Those Raw Materials. By C. A. WARD, A.M.I.E.E. London: George Allen and Unwin, Limited. [Price 15*s.* net.]

THERE have been many surveys of the sources, distribution and relative economic significance of the raw materials of industry during the past quarter of a century, but we do not recall any which has attempted, much less accomplished, its object with such a limited use of statistics as has been achieved in this book by Mr. C. A. Ward. The absence of both tabular and graphical statistics, indeed, is complete, such figures as he does cite being incorporated in the text, and practically confined to the section dealing with the world production of coal and petroleum in the years preceding the present war. At first sight it might appear that, in adopting this method of treatment, the author has imposed upon himself a gratuitous handicap; but the book is not addressed primarily to that class of reader to whom tables and graphs are a natural mode of expression. It is definitely "general" in character, in that it is intended for that wider public which has learned to appreciate that the problems associated with supplies of raw materials are of paramount importance to modern civilisation, but lacks the technical knowledge to understand clearly how that importance arises. As a background for a more detailed study of the economic and industrial questions involved, which is all that the author claims for it, the book is excellent; and it possesses the further merit that the more detailed study is not essential to an understanding of it by the ordinary citizen who desires no more instruction than will keep him reasonably *au fait* with current affairs.

The book is in three parts, dealing respectively with raw materials and their uses, their occurrence, and their preparation. The section on the occurrence of raw materials contains also the review of the world production of coal and oil, previously mentioned. A particularly useful feature, in the light of modern developments, is the attention given to alloys of metals, and to the wide range of chemical products, including dyestuffs and explosives, and synthetic materials. Rubber, resins, and the vegetable and animal fats and oils are also discussed. A separate chapter is devoted to timber—"the raw material with the most varied uses"; the significance of which has been brought home to the general public more effectively in the present war, perhaps, than ever before, as a result of the cessation of Scandinavian and Russian supplies, and the strict limitation of those from more distant sources.

It is only natural that the greater part of the book should be devoted to the many industrial uses and methods of preparing raw materials that have been developed in recent times—using the word "recent" in its historical sense; but the author has not disregarded the old processes, the origins of which, in some cases, must long antedate even the beginnings of written history. Marvellous as are the achievements of applied science, it is salutary sometimes to reflect upon the generations of trial and error, and the truly scientific acuteness of observation, that must have preceded the introduction of so world-wide a practice, for example, as the tanning of leather. By including such fundamental industrial arts as these within the scope of his survey, Mr. Ward recognises the continued existence, even in this age, which takes so much for granted, of the desire for general knowledge that was one of the mainsprings of Victorian progress; a point which should constitute an additional commendation of his book. Obviously, so wide a field as he covers has necessitated some reliance upon information acquired at second hand. In general, this appears to have been selected with care and discrimination. It is hardly correct, however, to state that "wrought phosphor-bronze is obtained by treating wrought bronze with phosphorus"; and while, metallurgically, it may be "suitable for such parts as . . . propeller blades," we have yet to hear of its actual use for such a purpose. Like many another engineer, he seems not to have realised that "wrought" is merely the past participle of the verb "to work."

THE LATE MR. J. S. TYZACK.—Mr. John Stanley Tyzack died on November 15 at Carlton, Worksop, Nottinghamshire, where he had been living for some months. As chairman and governing director of Messrs. W. A. Tyzack and Company, Limited, Stella Works, Hereford-street, Sheffield, 1, he was well known in Sheffield industrial circles. The firm, which produces knives and other parts for agricultural implements and various cutting tools for the engineering industry, was founded by Mr. Tyzack's father, the late Mr. W. Alexander Tyzack, and Mr. J. S. Tyzack joined it as a young man. Throughout his life he took an active part in the business, and although he had been in failing health for some months he continued to act as chairman and governing director until his death, which occurred at the age of 64. Mr. Tyzack was elected a member of the Iron and Steel Institute in 1933. His son, Mr. Donald Stanley Tyzack, is a director of the firm.

UNIVERSITY EDUCATION OF ENGINEERS.*

By Professor C. E. Inglis, O.B.E., F.R.S.

(*Concluded from page* 385.)

Drawing is another educational subject to which, in a university education, a time limit has to be imposed. The first-class draughtsman is the outcome of years of practice and experience, and a university course which specialised on this product would have time for nothing else. At a university, a grounding in drawing-office methods and considerable practice in solving engineering problems by graphical processes should be given; but, though the technique of high-class draughtsmanship ought to be set before students as a goal to be subsequently attained, they cannot be expected to reach this standard of perfection in the limited time available. A taste for the actual process of drawing is a very valuable asset, and an engineer who has never developed that taste, or has allowed it to fall into disuse, places himself at a disadvantage. Handing over a rough sketch to a draughtsman may produce one solution of a problem, but there is no assurance that it is the best. Work on a drawing-board is a slow process which gives plenty of time for thought and, as the design begins to unfold, various alternatives will almost inevitably present themselves and, more often than not, the final solution has little resemblance to the original conception. Hence I would advise any young engineer to cultivate a taste for drawing; to regard it as a valuable accomplishment, and not as a menial task associated with the less exalted stages of an engineering career.

The word "Research," in its application to engineering, can produce mixed emotions. It can conjure up the soul-stirring contributions to knowledge made by great scientists, such as Newton, Clerk Maxwell, Rutherford, and J. J. Thomson, while at the other end of the scale there is the dreary vision of research being basely used as a means of obtaining a cheap degree. Without any disparagement to the great pioneers of the past, it should be recognised that outstanding distinction in research is becoming increasingly difficult to achieve. The days are past when nuggets could be found lying about; the alluvial deposits have been worked out, and, to add to our stores of knowledge, deep-level mining is generally essential. Consequently, in engineering research, teamwork is tending to replace individual effort, with the result that personalities have less opportunity of becoming conspicuous. This tendency must, sooner or later, be recognised in the training for research and in the granting of research degrees. Often the best approach for a beginner in research is to serve an apprenticeship in a team already at work, but under present circumstances this course may seriously jeopardise his chances of a research degree. For this particular hall-mark, a premium is placed on individual effort and originality; consequently, the young research worker who has his eye on a degree is generally forced to plough a lonely and often shallow furrow, instead of digging deeply into some problem of first-rate importance, guided and stimulated by a band of fellow-workers. Unless this trend is recognised, and the value of team-work is taken into account in granting degrees, the training in research for university engineering students will become increasingly limited in scope and out of touch with modern methods.

At a university, research should, as far as possible, be of a fundamental and long-range character which may have no immediate or obvious practical value. Industrial research, where quick returns of a utilitarian character are called for, must be left, in general, to the research laboratories of commercial undertakings, particularly since such research is often of the full-scale variety, involving specialised and costly apparatus which a university research laboratory can neither finance nor accommodate. This question of the ever-increasing cost of engineering research is a serious consideration and suggests that, in post-graduate training and research, the universities, to some extent, should pool their resources. At present, their post-graduate activities overlap in a manner which is very uneconomical. After a student has graduated, he should be free to migrate to some other university which specialises in the particular line of knowledge he wishes to pursue, and this change of environment would often be greatly to his advantage.

Instead of all universities professing omniscience, one would like to see the subjects of post-graduate study apportioned to them, account being taken of their geographical position and the nature of their local industries. In this rationing process there are all the ingredients for a sanguinary dog-fight. It could be brought into effect only by invoking some high authority invested with dictatorial powers, but the gain would justify any temporary turmoil. Post-graduate teaching and research would gain strength by concentration, the channels of intercourse between industry and the universities would flow more fully in both directions, and particular industries would know more definitely where to turn when seeking guidance, or bestowing gifts for the encouragement of that special form of post-graduate training and research in which they are interested.

And now I will make a few observations on the technique of teaching. The accomplishments looked for in a teacher of engineering are two- and perhaps even threefold. He is generally expected to be not only an accomplished teacher, but also distinguished in research, and to these qualifications when a leading position is to be filled, administrative ability has to be added. These three attributes, teaching, research, and administration, are as widely separated as the corners of an equilateral triangle, and to find them all embodied in their highest development in any one single individual is almost too much to expect. Even teaching ability and distinction in research are apt to be in conflict, and if, as a teacher, a man's qualifications are "A1," it is more than likely that in research he cannot be rated higher than "B," and vice versa. In making an appointment to a post which is primarily of a teaching character, though a candidate's research record should be taken into account, this qualification, in my opinion, is often overweighted. It is not always sufficiently recognised that first-rate teaching ability is a gift vouchsafed to only a favoured few, and that its comparative rarity gives it a value which can hardly be over-estimated. It is all wrong to imagine that because a man is learned he can, in due course, become a good teacher, and this misconception applies with even greater force to ardent disciples of research. Consumed by a divine frenzy, the research enthusiast is apt to grudge every moment spent away from his beloved occupation, and a teacher who views his task as being of secondary importance is unlikely to be a success. Students pay their fees to receive tuition, and in return are entitled to receive the best teaching which can be provided; and, to satisfy their needs with the reluctant efforts of a man whose interest is mainly dedicated to research, is the perpetration of a flagrant breach of contract. Research is a vital necessity in any university engineering department, but it must not be subsidised out of the fees paid by students.

Thus, on the staff of a university engineering department, two categories should be recognised: those whose primary duty is to teach and those who are mainly occupied in research. In practice, however, this demarcation should not be too rigidly enforced. Every teacher, though his natural aptitude for research may be limited, should strive to make his modest contributions to knowledge, and every research worker will derive benefit by endeavouring to expound his ideas to an audience, though the members of this audience may sometimes have their own views about the value of this infliction.

For success in teaching, long experience is essential, and the teacher who has become self-satisfied with his efforts is already on the down grade. In addition to experience, certain natural qualities must have been inborn; for instance, a clear and musical voice is a valuable asset. But the most important attributes are enthusiasm and sympathy; a lecturer must face his class with the feeling that he has something perfectly splendid to tell them and they, above all others, are the young men with whom he wishes to share his soul-stirring secrets. Enthusiasm and sympathy are very infectious, and, if this atmosphere is created, a lecturer's task is more than half performed. For orderly arrangement of his material, and clarity of exposition, he must strive continuously without hope of finality; indeed, the most stimulating incentive to progress in teaching lies in the fact that finality in technique never can be attained.

If a lecturer is unfortunate enough to find his class restless or unruly, the blame almost invariably lies with him. It is generally an indication that his lecture has been insufficiently prepared and is lacking in the virtue of clarity, without which he cannot hope to hold the attention of his class. Clarity in a lecturer is a form of good manners he owes to his audience; without it, all his other excellencies are of no avail. Every teacher can with advantage study that sublime message of St. Paul to the Corinthians, substituting for "charity" the equally merciful and perhaps even more kindly virtue of clarity.

There is one important word of advice I feel impelled to give teachers. When examining a pupil's work in his presence, always in the first instance seek for something you can praise. If this can be done (and it is not always easy to do so) a student will pay much more heed to the condemnations you may have subsequently to make; he will take them to heart and accept them without resentment. It is a British characteristic to bestow praise much too sparingly. Most of us, young and old, benefit from an occasional dose of this tonic, and it is only the thick-skinned or entirely self-satisfied who don't find it invigorating and a stimulus to renewed effort. It is a mere truism to say that the best teachers are not necessarily those who possess the most brilliant academic records; indeed, extreme mental acumen may almost be a drawback. A teacher is more likely to be in sympathy with his pupils if, in the past, he has encountered and surmounted by conscious effort just those same difficulties which confront the student of average ability; and the super-brilliant mind which has acquired knowledge almost subconsciously may have difficulty in appreciating the perplexities which beset those of lower intelligence. Finally, on this subject of engineering teaching, I would add that, as a foundation for such a career, some practical engineering experience is essential, of an amount not less than that required by this Institution as a qualification for associate-membership.

A question which is frequently asked is, "How do engineering students nowadays compare in ability and diligence with those of the past?" My answer is that, in general, the present generation has become more studious. Owing to the increased tempo of the educational system, there are fewer opportunities than formerly for loitering by the wayside; a student must keep moving all the time. He realises that his mental efforts cannot be reserved exclusively for the period just preceding an examination, and though, to some extent, diligence may be thus forced upon him, the serious-minded and vigorous manner in which the great majority of students now pursue their studies is a cheering indication of the backbone possessed by the rising generation in this country. Concerning ability, a general up-grade is certainly apparent, though the high-water mark of intelligence of the very best remains sensibly constant. This, I conceive, may be in accordance with a law of Nature which has set a limit to human intelligence which few attain and none surpass, and I believe that, going back as far as historical evidence can take us, the outstanding examples of human intelligence have been of equal distinction quite irrespective of age or nationality.

In conclusion, I will address myself more particularly to those young men who are still only on the lower rungs of their professional ladder, but with the glorious buoyancy and optimism of youth, are confident of rising ultimately to the top. That, at any rate, is the right spirit in which to start the ascent, and the vista of sustained effort which lies ahead should only add zest to your high courage. For sustained effort is essential, and the upper rungs of the ladder are not reached by those who put their faith in any doctrine of "least effort." Academic success may and should help you to make a flying start, but the initial propulsive force of postscripts such as "B.A.," "B.Sc.," or even "Ph.D.," is soon spent, and your ultimate progress will depend on your own powers of propulsion and not on scholastic or even university distinctions. You will be judged by what you are, and not by what you have been. One of the early qualifications you should have acquired is the power of concentration, and in developing this faculty I think modern educational methods are somewhat defective. Although I would not wholly subscribe to the doctrine propounded by that semi-serious philosopher Mr. Dooley, that "it doesn't matter what you teach a boy as long as he hates it," nevertheless it contains a substratum of truth and is a bracing antidote to the flabby idea of "education without tears," and the doctrine that knowledge must always be served up in a palatable form. Having occasionally to concentrate on a task which at first sight may not appear attractive provides that invigorating tonic of mental discipline which in an engineering education is such an essential ingredient. In most professions, and engineering is no exception, there is much work to be done which the mentally undisciplined may regard as a bore; but boredom in the young is a shame-making exhibition, indicating lack of grit and deficiency in powers of concentration. In planning your life, think more about what you can give than what you can get out of it, and don't place "having a good time" in the forefront of your objectives. If you do, most certainly you will be disappointed. Happiness is as intangible as the ends of a rainbow; it is a commodity which you cull from the roadside as you run your course through life; it must be regarded as a by-product, and not as the main purpose of existence.

I have spoken of various attributes which you should possess and cultivate; but the most valuable of all is that form of courage which refuses to admit defeat and, if there is one factor which more than another makes for success in life, it is the ability to draw dividends from defeat. Defeats must come to all who live adventurously, but don't for a moment confuse defeat with failure; if you do, you are doomed to fail. Don't regard defeat as an irrevocable disaster, but rather view it as a valuable experience. Seek, and you will find, a way of turning your passing loss into a permanent gain.

I shall finish with an extract, perhaps not inappro-

* Presidential address to the Institution of Civil Engineers, delivered in London on Tuesday, November 4, 1941. Abridged.

priate to a conclusion, since it takes the form of a prayer. It was written by a bishop whose identity I have been unable to discover, but it is obvious that he must have been a really human divine who saw life and the essentials thereof in their proper perspective. His petition includes all the qualifications I have emphasised you should possess, with several others I might have mentioned, and its sanity and sound common sense should have made it more generally known. It reads as follows:

"Give me a good digestion, Lord, and also something to digest;
Give me a healthy body, Lord, with sense to keep it at its best;
Give me a mind that is not bored, that does not whimper, whine or sigh;
Don't let me trouble overmuch about that fussy thing called 'I';
Give me a sense of humour, Lord, give me the grace to see a joke;
To get some happiness from life, and pass it on to other folk."

TELEPHONY OF THE FUTURE.

LECTURING, on October 15, to the London Students' Section of the Institution of Electrical Engineers on "Telecommunications of the Future," Dr. W. G. Radley, of the Post Office Research Station at Dollis Hill, said that although in 1914 wire telephony had been in use for about 40 years, and had become an important factor in the social and business life of urban communities, the loss in speech power during transmission imposed definite limits to long-distance conversations. These limits disappeared as a result of the general introduction of thermionic-valve amplifiers early in the interval between the two European wars. Later, the operation of the long-distance circuits, which had been made possible, was cheapened by the development of systems of carrier-current telephony, culminating in a standard system providing 12 speech channels over one pair of wires. A form of coaxial cable was then introduced which was capable of transmitting television, or providing several hundred speech channels over two conductors. In the meantime, the transmission of speech by radio had made world-wide telephony possible and had finally solved the problem of overcoming distance and physical barriers.

Each of these developments had come as the result of a long period of experimental work, and in the light of the stage to which research had been carried by 1939 it was possible to hazard a guess at the nature of the post-war telephone system. The disappearance of metallic conductors and the transmission of long-distance speech by means of what were virtually guided radio waves was a possibility of the future. It was true that radio transmission would probably never oust some method of line transmission for circuits confined entirely to land, but modern methods of line transmission owed much to technique borrowed from the radio field. The use of quartz-crystal elements for accurate frequency generation and control, and also in the construction of efficient electrical filters, were examples.

Research into the nature of speech sounds had recently made it possible to construct a machine which would speak under the control of an operator at a keyboard. An extension of the system on which this operated might lead to the possibility of analysing speech in a local circuit, transmitting signals corresponding to the results of the analysis over a long-distance line, and automatically reconstructing the speech at the distant end. The frequency band necessary for the transmission of the signals over the long-distance line was very much narrower than that required for ordinary telephony so that more circuits could be obtained from long expensive submarine telephone cables. The energy in the speech currents received at the distant end of such a cable was so small that it might be compared to that of starlight.

Improvements in the post-war period would probably lead eventually to the disappearance of telephone operators, except for special services, equipment being employed by means of which any subscriber would be able to obtain any other, in his own country, by dialling. Contemporary methods of switching telephone circuits involved the movement of heavy electro-mechanical parts, but the introduction of entirely new methods was possible. Although no immediate change in principle was foreshadowed, improved fidelity of response of microphones and telephone receivers was probable. Other problems which were the subject of research were the elimination of circuit noise, switch-contact noise and resistance noise. The efforts of modern scientific research were directed towards making telephone conversation between any two persons anywhere, immediate, intimate and inexpensive.

THE ROLLING OF A MAGNESIUM ALLOY.*

By PROFESSOR W. R. D. JONES, D.Sc., and L. POWELL, B.Sc.

(*Concluded from page* 346.)

SHEETS ROLLED FROM EXTRUDED SLABS.

A CHILL-CAST circular ingot was teemed from the same ladle of molten alloy as that from which the cast slabs were produced. This ingot was then extruded by Messrs. Magnesium Elektron, Limited, in the form of two long plates, $\frac{5}{8}$ in. thick. The surfaces of the extruded slabs were sufficiently good not to require machining before rolling. The slab was cut into suitable lengths, which were placed in a furnace the temperature of which was stationary at 450 deg. C. The slabs, after being maintained at this temperature for one hour, were withdrawn and cooled in air. The procedure for hot rolling to No. 10 gauge was that adopted previously, except that the rolling of the extruded slab was started when the thickness was $\frac{10}{64}$ of an inch. The hot and cold rolling of the sheets to No. 16 gauge and their testing were also carried out in the same way as before.

Discussion of Results on Sheets Produced from Extruded Slabs.—The effect of cold work on the ultimate stress was not appreciable—there was a slight increase on cold working up to 25 per cent. extension which was followed by a decrease on further cold working, but even after 100 per cent. cold extension the values were not lower in the "strong" direction than those given by the hot-rolled sheet. There are indications that small amounts of cold work, such as that produced by 5 per cent. cold extension, were harmful, but intermediate amounts such as 10 per cent. to 25 per cent., resulting in some stiffening, while if the cold rolling was heavier than that given by 50 per cent. extension the ultimate stress was lowered. This was marked in the case of specimens cut parallel and at 45 deg. to the direction of rolling, and the greater the degree of cold work the more pronounced was the directionality. The effect of annealing was not beneficial. After annealing at temperatures higher than 100 deg. C., the values in the strong direction were all between 16 tons and 17 tons per square inch, and were independent of the annealing temperature and of the amount of cold work. For each degree of cold work there was, in general, a uniform slight lowering of the tenacity with increasing annealing temperature. The imposed directionality was not influenced by annealing even up to 500 deg. C. The limit of proportionality was affected only after the sheet had been given about 50 per cent. cold extension. The effect of annealing sheets that had received small amounts of cold work was negligible up to an annealing temperature of 300 deg. C., but if sheets had been given heavier cold work—more than about 25 per cent. extension—annealing decreased the test values slightly. Cold working to give an extension of 25 per cent. increased the proof stress, which was reduced by further cold work, but even a cold extension of 100 per cent. did not reduce the value below that given by hot-rolled sheet. Annealing caused a reduction in the proof stress irrespective of the amount of cold work, the decrease being uniform with an increase of annealing temperature. If annealing were carried out at temperatures higher than 200 deg. to 300 deg. C. on sheets that had received more than small amounts of cold work the effect was decidedly harmful. Further, the values for the proof stress in varying directions were very different and the directionality was not diminished by annealing.

Cold work seriously lowered the elongation and in the case of sheets that had received more than 10 per cent. cold extension the values in the weaker directions were almost negligible. The elongation figures of sheets given more than 50 per cent. cold extension were not improved by annealing. With medium amounts of cold work annealing restored somewhat the elongation figures. Cold working up to 10 per cent. extension increased the hardness of the sheets, but beyond this amount the hardness was not affected. Annealing caused a progressive lowering of the hardness figures and the greatest softening occurred at 300 deg. C. A higher annealing temperature had little effect—the sheets were softened to a value that was independent of the amount of cold work.

Summarising the results of these tests, it can be stated that, while small amounts of cold work increased the strength, there was a more than corresponding decrease of ductility. Any appreciable amount of cold work caused a general lowering of tenacity as well as ductility. Pronounced directionality was conferred by rolling and the preferred orientation persisted even after annealing at temperatures as high as 500 deg. C. The results of tests taken at 45 deg. to the direction of rolling showed this to be a decided "weak" direction—the test figures approximating much more to the longitudinal or "weak" direction than to those obtained in tests carried out on specimens transverse to the direction of rolling, *i.e.*, the "strong" direction. The properties were little affected by annealing, which on the whole was permissible if the temperature did not exceed 300 deg. C. The hardness of the rolled sheets was related to the annealing temperature and not to the amount of cold work above 5 per cent. extension, and here again annealing at temperatures higher than 300 deg. C. did not cause further softening.

It was found that cold-rolled sheets had practically the same grain-size irrespective of the amount of cold extension—a grain-size that was coarser than that of the hot-rolled sheets. This can be explained somewhat by the fact that, before cold rolling, the sheets had received varying amounts of hot rolling followed by an annealing treatment at 450 deg. C. for 1½ hours before the subsequent cold rolling. Annealing at temperatures up to 300 deg. C. did not alter the grain-size appreciably if the amount of cold work was not more than that equivalent to a cold extension of about 50 per cent., but if the annealing temperature were more than 400 deg. C. grain growth was pronounced.

Comparison Between the Properties of Sheets Rolled from Cast Slabs with those Rolled from an Extruded Slab of the Same Composition.—Higher values for the limit of proportionality were obtained for sheets rolled from cast slabs. Annealing up to 300 deg. C. caused some improvement in sheets rolled from cast slabs, but had no effect on sheets rolled from the extruded slab. Directionality was the same in both cases and was not reduced by annealing. The curves for the proof stress were the same for both types of sheets with, if anything, slightly higher values for sheets produced from cast slabs, particularly after heavy cold work. The ultimate stress figures were almost identical except that after 100 per cent. cold extension the values for sheets produced from cast slabs were low. The curves for the tenacity figures in the two "weak" directions follow the same trend for sheets produced both from cast and extruded slabs—the strength in the weaker directions falls off after 50 per cent. cold extension for cast slabs compared with 75 per cent. for extruded slabs. Directionality became more pronounced the greater the degree of cold work and was not improved appreciably by annealing even at temperatures as high as 500 deg. C. The sharp difference between the properties in the strong and weak directions of the ultimate stress compared with the corresponding figures for the limit of proportionality and the proof stress was observed in sheets produced from both cast and extruded slabs.

With regard to the ductility of the two sets of sheets, the values for the elongation were similar. In the "as-rolled" condition the sheets rolled from the extruded slab were slightly the better, but on annealing at 300 deg. C. or higher, the effect was greater on sheets that were produced directly from cast slabs, and this was particularly the case for sheets that had received heavy cold work. The more or less harmful effect of small amounts of cold work—an effect that was not removed on annealing until the temperature had exceeded 300 deg. C.—was not so pronounced in the case of sheets produced from extruded slabs as those from cast slabs. Although sheets produced from the extruded slab with 50 per cent. cold extension were more ductile than the sheets produced with less cold work, the values after annealing at 400 deg. C. were little better than those produced from cast slabs; while the ductility of sheets given more than 50 per cent. cold extension was definitely higher for sheets produced from cast slabs—the values being 9 per cent. to 10 per cent. elongation compared with 4 per cent. to 5 per cent. for sheets produced from the extruded slab.

With one or two minor exceptions, the hardness curves had the same characteristics whether the sheet was produced from the cast slab or the extruded slab, but the values were consistently about 2 numbers to 4 numbers higher in the case of the former sheets—almost within the limit of experimental error. The difference in grain-size between the corresponding sets of sheets was noticeable, and allowing a counting error of about 10 per cent. range, the grain-size of sheets produced from cast slabs was in almost every case the finer. The difference, however, is one of detail rather than of degree.

General Conclusions.—The general conclusions that can be drawn from these series of experiments are as follows: Sheets can be produced by rolling direct from cast slabs which have mechanical properties at least equal if not superior to those produced from extruded slabs. While small amounts of cold rolling increased slightly the tenacity there was a more than corresponding decrease of ductility. Heavier cold work, up to 75 per cent. extension, does not further affect the tenacity appreciably. The thickness of the sheet before rolling was an important factor for higher amounts of cold extension. Very small amounts of cold work are harmful and the inferior mechanical

* Paper presented to the Institute of Metals for written discussion. Abridged.

DRYING GASES BY ACTIVATED ALUMINA.

MESSRS. BIRMINGHAM ELECTRIC FURNACES, LIMITED, BIRMINGHAM.

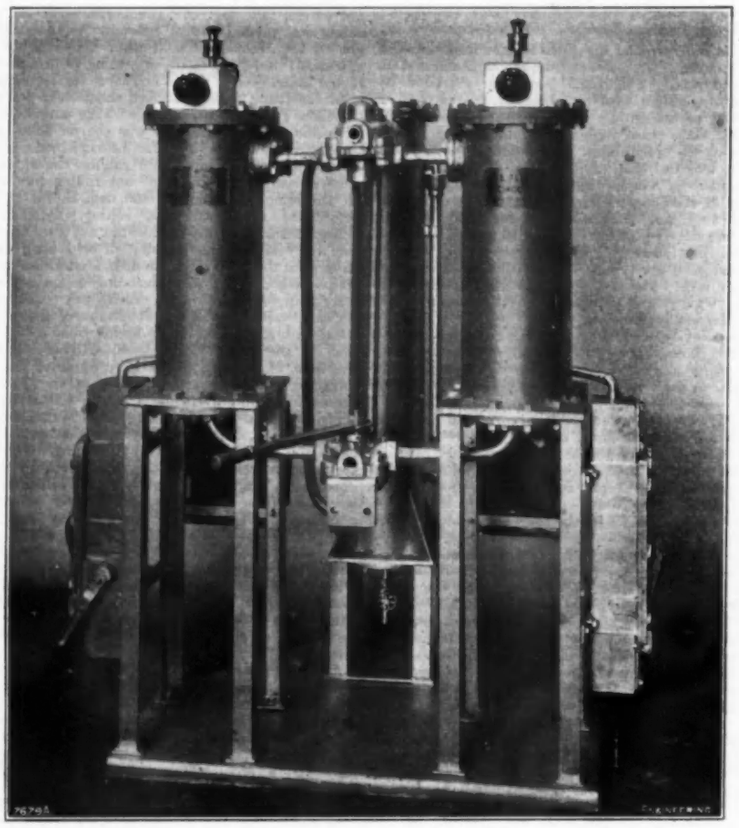


FIG. 1.

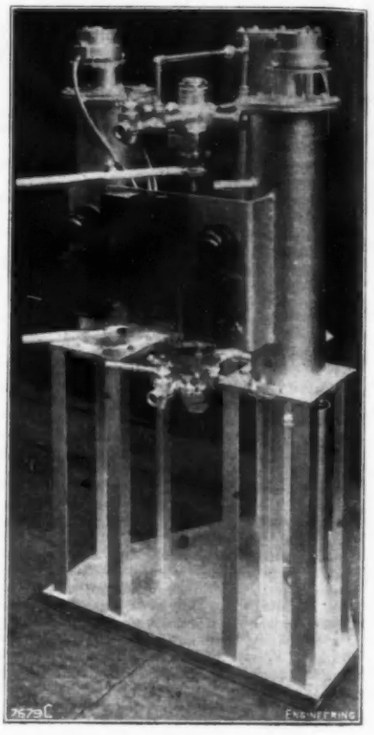


FIG. 2.

properties produced are not improved by annealing. The mechanical properties of cold-rolled sheets are not improved to any important extent by annealing. If annealing is carried out, the temperature should not be higher than 300 deg. C. Rolling produces marked directional properties which are not eradicated by annealing at temperatures even up to 500 deg. C. There is no critical combination of cold work and annealing temperature that gives rise to excessive grain growth accompanied by decreased mechanical properties such as is known to be the case with certain other materials.

THE DRYING OF GASES BY ACTIVATED ALUMINA.

THE problem of drying air and other gases has been solved in a number of ways in various industries, and, while in some cases refrigeration has been resorted to, the use of desiccating agents, including calcium chloride, phosphorus pentoxide and silica gel, is more general. An interesting adsorbent, which appears to possess a number of advantages over other drying materials, is activated alumina, which has been developed during the last few years. It consists essentially of alumina in a porous amorphous form, and, we understand, is capable of drying gases to a moisture content of 0·005 grain per cubic foot, and of adsorbing up to about 20 per cent. of its mass of water. The particles of the material, which are available in a wide range of sizes and are chemically inert to many reagents, are highly resistant to mechanical shock and will undergo repeated cycles of adsorption and reactivation without crumbling or loss of adsorptive efficiency. Maintenance costs are therefore kept down to a minimum, as no replacement of the adsorbent is needed. Reactivation is effected simply by heating the spent alumina to a temperature above 180 deg. C. and providing means for the removal of the water vapour evolved. Activated alumina is now incorporated in specially designed air and gas drying units, known as Birlec Lectrodryers, made by Messrs. Birmingham Electric Furnaces, Limited, Birlect Works, Tyburn-road, Erdington, Birmingham, 24. As a general rule, the alumina is arranged on perforated trays in cylindrical towers, one tower being employed if intermittent drying of a gas is required and two for continuous operation. In the latter case one of the towers is used for adsorbing moisture while the other is undergoing regeneration.

The principle employed will be clear from the flow diagram Fig. 3, on this page. The change-over of the gas flow from one cylinder to the other is effected by the operation of the two four-way valves shown. Heat for the reactivation is supplied by electric heating elements or steam coils embedded in the alumina and, in the larger units, water is employed to cool the beds after reactivation. Moreover, in cases in which maximum efficiency is required, the passage of the cooling water is continued during adsorption to keep down the temperature of the alumina beds, since the lower the temperature the more efficient will be the adsorption. The cooling water is passed through the same coils as convey the heat during the reactivation operation. A special arrangement is available whereby the actual process gas may be used to carry off the moisture evolved during the reactivating operation. This form of apparatus is particularly useful for dealing with costly gases or gases liable to form explosive mixtures with air, as the need for purging the apparatus is eliminated. The principle of this form of apparatus is shown in Fig. 4 and general views of typical installations are given in Figs. 1 and 2. It will be seen that the moist gas, after passing through the heated cylinder undergoing reactivation, is led into a condenser in which most of the entrained moisture is deposited. The gas is then finally dried by passing it through the adsorbing cylinder.

Units are available in a series of standard sizes capable of handling gas flows ranging from 100 cub. ft. to 15,000 cub. ft. per hour, while still larger units can be designed and supplied. Fig. 2 shows the firm's type B.A.C. 10, for drying hydrogen at a rate of flow of 100 cub. ft. per hour. The twin activated-alumina cylinders, and the condenser behind them, are supported on angle-iron pedestals, and the illustration also shows

Fig. 3.

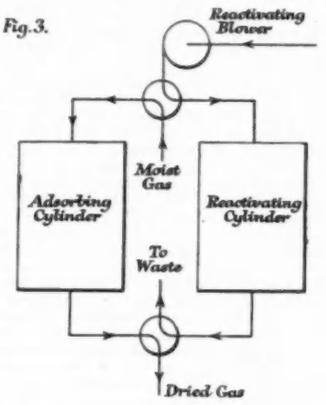
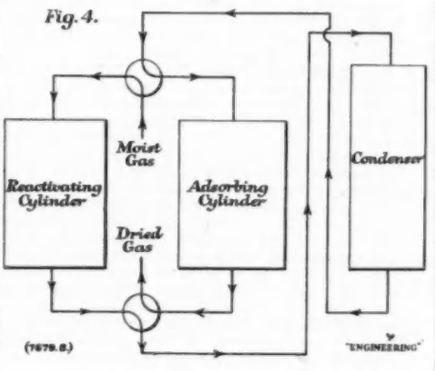


Fig. 4.



RAPID PRODUCTION OF SHEET TEMPLATES.

MESSRS. WESTLAND AIRCRAFT, LIMITED, YEOVIL.

FIG. 1. SETTING OUT CONTOURS ON MASTER TEMPLATE.

FIG. 2. INKING SCRIBED MASTER TEMPLATE.

the two four-way valves and interconnecting piping. The electrical gear, switch fuses, relays, and pilot lights, are mounted on a panel between the cylinders. In addition, units are made for drying gases at high pressures, up to 2,000 lb. per square inch. That seen in Fig. 1 is used for drying hydrogen at a pressure of 100 lb. per square inch. Apparatus supplied for operating at high pressures is often equipped with a filter unit to remove the last traces of oil carried over by the moist compressed gas from the compressors, and this prevents the contamination of the adsorbent in the drying cylinders. The filter unit consists of a combined mechanical filter and adsorption unit, a portion of the oil being deposited mechanically and the last traces extracted by activated alumina contained in a removable basket. When it becomes saturated with oil, the adsorbent is either cleansed or replaced by fresh material; by-passing can be arranged so that there need be no interruption of the gas flow during the replacement.

Another type of dryer is available in the form of a small cylindrical unit for use as a "breather" on tanks where the exclusion of moisture is necessary. These small units are removable and portable, and, for a battery of storage tanks, a breather for each tank, together with a spare unit, is the most suitable arrangement. The alumina is impregnated with a moisture-sensitive coloured indicator, and when, by inspection through a window, the adsorbent is shown to be exhausted, the breather is removed and the spare unit put in its place. The spent breather is then taken to a central reactivating plant comprising a heater and fan.

Originally developed in this country in connection with the supply of special dry protective atmospheres for bright-annealing furnaces, the Birlec Lectrodryer has now found application in other industries. It is employed, for instance, for the drying of the hydrogen used in the reduction of metallic oxides; for drying air and other gases to prevent condensation in pipe lines and the freezing-up of expansion valves; for the preliminary drying of air and oxygen in the production of compressed gases; for the drying of carbon dioxide in the manufacture of "dry ice" and in connection with air conditioning, especially in the chemical and similar industries, where a low relative humidity is required for the processing or storage of various chemicals. Moreover, activated alumina may also be used in the drying of liquids such as refrigerants, transformer oils and various organic liquids.

MAXIMUM PRICES FOR OVERALLS.—The Board of Trade has issued the Utility Apparel (Maximum Prices) (No. 5) Order, 1941 (S.R. & O. 1941, No. 1691, price 1*d*.). This fixes maximum prices for men's bib and brace overalls and boiler suits.

RAPID PRODUCTION OF SHEET TEMPLATES.

AN ingenious and economical process for accelerating the production from the mould loft of construction templates for prototype aircraft has been developed recently by Messrs. Westland Aircraft, Limited, Yeovil. Two stages of the process are illustrated in Figs. 1 and 2, on this page, from which it may be inferred that it is based on the two ancient crafts of engraving and printing. These have, however, been modified to suit the end in view and the resulting simple process is now made public in the hope that its adoption generally will assist in increasing the rate of template production and thus in reducing the time in which a prototype aircraft can be completed. It may be mentioned that the new process has been adopted after extensive research had shown that other possible solutions of the problem were more expensive in practice and offered no compensating advantages.

The master-template is laid out in the mould loft, this operation being illustrated in Fig. 1. The lines of the airframe components are set out from the design drawings to form hand-scribed master-templates. The next stage, that of reproducing copy-templates from the master-templates for use in the shops, had hitherto been laborious and was liable to inaccuracy since the copying had also to be done by hand. It may be necessary to produce more than one copy-template from the same master-template, in which case the tediousness of the method is still more marked. In the new process, copies are printed from metal to metal, from the master-template to the copy-template by direct contact, employing wholly mechanical means. The final steps of completing a copy-template consist of roughing out the contour by a high-speed routing machine and finishing it by means of a band-filing machine.

The process is applicable to sheets as large as 8 ft. by 4 ft., though for convenience sheets measuring 6 ft. by 2 ft. are more commonly used. Since a printing process is involved, the surfaces of the plates must have a slightly rough texture. This is obtained by surface etching both the master-template and copy-template sheets with a 15 per cent. aqueous solution of caustic soda at a temperature of 70 deg. C. The sheets are then well washed in cold water and a mat finish results, which will take ink satisfactorily. The copy-template, which receives the impression, must, however, be of light colour, so as to show up the lines transferred to it and it is, therefore, sprayed uniformly with dope-resisting white paint after the etching process. The master-templates are usually of aluminium sheet but the copy-templates are of mild steel to prevent denting and buckling in the shops.

The master-template sheets are covered with light scribed lines in the manner of "squared paper" for reference and checking purposes and the contour lines are traced round weighted flexible battens, a more pronounced score being made by a scriber having a specially-formed point. This scoring results in the formation of two minute ridges of metal about 0·0012 in. apart, one on each side of the groove. When the plate is inked these ridges take the ink with the rest of the surface while the groove remains clear. When, therefore, the master-template sheet is pressed into contact with the copy-template sheet the ridges print off two clear black lines with a white space between them. Some of the ink on the other parts of the surface is also transferred to the copy-template sheet but only sufficiently to emphasise the squared lines since the contact is less close over this surface than along the ridges. The ink is applied by a hand roller in the same way as a printer inks his type before taking a proof. The process of inking is illustrated in Fig. 2.

In the right background of this figure is shown the press in which the transfer from the master-template to the copy-template is effected. This press, originally used for other purposes, is a power-driven screw press and has been adapted by fitting two heavy steel platens provided with rubber facings 1½ in. thick. The rubber ensures uniform contact over the comparatively large area involved, this contact being more important than heavy pressure. Part of a sheet for a copy-template is seen on the bottom platen of the press in Fig. 2, and the inked master-template having been placed face down on it, pressure is applied and the operation of printing effected. On withdrawal of the sheets, that for the copy-template bears two clearly-marked black lines with a white space between them for the contour, along with fainter lines showing the squares. To avoid risk of the black lines of the contour being obliterated, the white line is defined by centre-popping along it. The sheet is then transferred to the routing machine and cut approximately to the contour, which is, however, accurately finished by the band-filing machine, the operator watching the point of contact of the file through a strongly-magnifying lens. The only hand filing needed is that which may be required to smooth off any burrs.

Apart from the fact that the same copy-template may be repeated, the process has the additional advantage that a master-template is not required for each contour. This will be clear from Fig. 1, in which it will be noticed, near the left elbow of the man on the right, that a group of contours has been marked out on the master-template. All these may be used to make impressions on the sheet of the copy-template, but there is no difficulty in selecting one to which to cut the template and repeating the printing operation for the other contours. In practice the adoption of this method of producing templates has effected a great saving in

time. One example may be cited, viz., that of a series of copy-templates which was produced ready for routing and filing to shape in an hour, as compared with 12 hours which would have been needed to obtain the same result by the method formerly employed. In general, an average reduction of 70 per cent. to 80 per cent. in the time formerly taken to reproduce templates has been made possible by the process.

ANNUALS AND REFERENCE BOOKS.

The Electrician Annual Tables of Electricity Undertakings. Fifty-third Edition, 1941.—As present circumstances have prevented the publication of the annual reports of the Central Electricity Board, summarised statistics of plant capacity and output for the 1937-1938 period have been made available and a half-promise has been given that corresponding figures for 1939-1940 may shortly be issued. The reason for this reticence is well understood, and there will be no tendency to complain about it, but nevertheless it is an inconvenience which makes the reappearance of the *Electrician Annual Tables* doubly welcome. It was not found possible to publish these tables in their normal sequence in the spring of 1940 and the present edition, appearing towards the end of 1941, may be taken to cover this year and next. The compilation of the work must have presented considerable difficulty and the Annuals Department of Messrs. Benn Brothers, Limited, the publishers, are to be congratulated on its accomplishment. There are naturally gaps in the information provided, this applying particularly to Table D, which covers Foreign Undertakings, Germany and all places in enemy occupation necessarily being excluded; particulars of voltages, plant and output for Marseilles, however, are given. The tables appear in their usual form and do not seem to have been seriously affected by the present paper situation. They cover respectively British Undertakings; Power Companies; Dominion and Colonial Undertakings; and Foreign Undertakings. An introductory section deals with the National Power Scheme, details being given of the various areas, selected stations, owners and tariffs, and there is a map showing the grid transmission lines. For the type of information which they have so long been in the habit of using, manufacturers and electricity-supply officials may still turn with confidence to the main tables. The address of Messrs. Benn Brothers is Bouverie House, 154, Fleet-street, London, E.C.4, and the price of the publication is 12*s.* 6*d.* net.

JUNIOR INSTITUTION OF ENGINEERS.—At the annual general meeting of the Junior Institution of Engineers, held on November 15, Mr. Norman L. Ablett, B.Sc., Wh.Ex., was elected chairman. Other elections comprised those of Messrs. H. S. Rentell and J. Calderwood, M.Sc., as vice-chairmen; that of Mr. H. G. Pusey, A.M.I.Mech.E., as honorary treasurer; that of Dr. Herbert Chatley, M.Inst.C.E., as honorary editor; and that of Mr. F. Squirrell as honorary librarian. Messrs. L. S. Atkinson, A.M.I.E.E., J. E. Gray, and R. W. Winterborne were elected members of the Council, and Mr. A. J. Gatrill was made a junior councillor.

THE IRON AND STEEL INSTITUTE.—The annual autumn meeting of the Iron and Steel Institute will be held at 4, Grosvenor-gardens, London, S.W.1, on Tuesday, November 25, at 2.45 p.m. After the transaction of official business three papers will be presented for discussion, namely, "Apparent Relations between Manganese and Segregation in Steel Ingots," by Mr. J. H. Whiteley; "The Application of Spectrographic Methods to the Analysis of Segregates," by Messrs. F. G. Barker, J. Convey and J. H. Oldfield; and "The Ladle Cooling of Liquid Steel," by Mr. T. Land. A fourth contribution, entitled "A Cooperative Investigation of the Factors Influencing the Durability of the Roofs of Basic Open-Hearth Furnaces," submitted by the Open-Hearth Refractories Joint Panel, will also be presented.

THE LATE MR. C. E. DICK.—We note with regret the death of Mr. Charles Edward Dick, which occurred at his home, the Hall, Chorley Wood, Hertfordshire, on November 12. Mr. Dick, who was one of the pioneers of the British lubricating-oil industry, was chairman of Messrs. W. B. Dick and Company, Limited, and of Messrs. W. B. Dick and Company (Holdings), Limited, manufacturers of lubricants. He had been associated with the oil industry since 1891, when he entered the works established in Glasgow, in 1853, by his father, the late Mr. William Bruce Dick. Some years later he started up a separate works at Liverpool and was subsequently mainly responsible for building up a large connection with shipping companies in all parts of the world. He remained engaged in his companies' affairs until some six months ago, when an illness compelled him to relinquish some of his activities, but he retained his interest in the business until the end. Mr. Dick was 74 years of age.

INSTITUTION ELECTIONS.

INSTITUTION OF CIVIL ENGINEERS.

Member.—Geoffrey Murton Gill, Cheltenham; Fred Bernard Kerridge, Beguildy, near Knighton, Radnor; Sir Alexander Macdonald Rouse, C.I.E., F.C.H., Twickenham, Middlesex.

Associate Member.—Frederic Pasley Alban, B.Sc. (Eng.) (Lond.), Hemel Hempstead; Jack Beetham, B.Sc. (Manch.), Burnley; Geoffrey Wardle Bell, M.C., B.Sc. (Durham), Newcastle-upon-Tyne; Richard Colville Burton, South Shields; William John Charlton, B.Sc. (Leeds), Gresford, near Wrexham; Vernon George De Sevigne Coleman, B.Sc. (New Zealand), Auckland, N.Z.; Alfred Eric Ridgway Cope, Appleby, Westmorland; William Lightbody Dale, Lerwick, Shetland; Arnold Haydn Davies, B.Sc. (Wales), Prestatyn, Flint; Gadadhar De, B.Sc. (Bristol), Bath; Arthur Fisher, Keighley; Peter Alfred Greenway, B.Sc. (Eng.) (Lond.), Cardiff; Frederick John Hale, Dominica, Leeward Islands; Gilbert John Hoad, Reigate, Surrey; Laurence Leslie Huss, Dunblane, Perthshire; Bangalore Varadiyengar Seetharama Iyengar, B.Sc. (Eng.) (Lond.), London, E.17; Howard Elias Jones, B.Eng. (Liverpool), Wakefield; Leslie James Kastner, M.A. (Cantab.), M.Sc. (Manch.), Marple, Cheshire; Charles Leng, Watford, Herts.; Charles Gerald McNamara, B.E. (National), Glenageary, Co. Dublin, Eire; Andrew Macartney Malcolm, M.A. (Edin.), Blairgowrie, Perthshire; Alexander Millar, Belvedere, Kent; Sidney Myer Myers, B.Sc. (Eng.) (Lond.), London, N.W.2; William Thomas Oliver, B.Sc. (Durham), Wylam, Northumberland; Michael Joseph O'Sullivan, B.E., B.Sc. (National), Cork, Eire; William Hugh Owen, Surbiton, Surrey; John Herbert Quayle, Boston, Lincs.; Arthur John Edward Ridley, Pretoria, S. Africa; Wilfred John Rittman, Harrow Weald, Middlesex; John Riseley Robinson, Hounslow, Middlesex; Oliver Cyril Rowe, Tadcaster, Yorks.; Walter Richard Rowland, Cape Town; Harrison Simpson, B.Sc. (Eng.) (Lond.), Gateshead; Cyprian Mitford Slocombe, Sheffield; Harry Cresswell Steeples, Harpenden, Herts.; Frederick Maurice Watts, London, S.W.17, Randal Herbert Wood, B.Sc., Ph.D. (Leeds), Wolverhampton.

BOOKS RECEIVED.

Department of Scientific and Industrial Research. Road Research Laboratory. Wartime Road Note No. 3. Issued in co-operation with the Ministry of War Transport. *Recommendations for Open-Textured Asphalt Carpets.* London: H.M. Stationery Office. [Price 6*d.* net.]

Press Tool Practice. Part I. By P. S. HOUGHTON. London: Chapman and Hall, Limited. [Price 13*s.* 6*d.* net.]

When We Build Again. A Study Based on Research Into Conditions of Living and Working in Birmingham. A Bourneville Village Trust Research Publication. London: George Allen and Unwin, Limited. [Price 8*s.* 6*d.* net.]

Algebraic Solid Geometry. An Introduction. By S. L. GREEN. London: Cambridge University Press. [Price 6*s.* net.]

The Aircraft Press Tool Maker. By W. S. B. TOWNSEND. London: Sir Isaac Pitman and Sons, Limited. [Price 5*s.* net.]

Annual Report of the Minister of Mines of the Province of British Columbia for the Year Ended 31st December, 1940. Victoria, B.C.: British Columbia Department of Mines.

Department of Scientific and Industrial Research. Building Research. Wartime Building Bulletin No. 18. *Fire Stops for Timber Roofs.* London: H.M. Stationery Office. [Price 1*s.* net.]

Lessons in Arc Welding. Second edition. Cleveland, Ohio, U.S.A.: The Lincoln Electric Company. [Price 50 cents.] Welwyn Garden City, Herts: Lincoln Electric Company, Limited.

Ministry of Supply. Welding Memorandum No. 5. *Memorandum on the Replacement of Drop Forgings and Pressings by Welded Parts.* London: Advisory Service on Welding, Directorate of Scientific Research, Ministry of Supply, Great Westminster House, Horseferry-road, S.W.1.

Teach Yourself Mechanics. By P. ABBOTT. St. Hugh's School, Bickley, Kent: The English Universities Press, Limited. [Price 2*s.* 6*d.* net.]

United States National Bureau of Standards. Building Materials and Structures. Report BMS 75. *Survey of Roofing Materials in the North Central States.* By H. R. SNOKE and L. J. WALDRON. Washington: Superintendent of Documents. [Price 15 cents.]

Department of Scientific and Industrial Research. Road Research Laboratory. Wartime Road Note No. 4. Issued in co-operation with the Ministry of War Transport. *Salt Treatment for Icy Roads.* London: H.M. Stationery Office. [Price 6*d.* net.]

PERSONAL.

MR. JOHN MACLEIGH, Director of the Mines and Geology Division of the Canadian Department of Mines and Resources, Ottawa, has retired. He has been succeeded by MR. W. B. TIMM, who has been chief of the Canadian Bureau of Mines since 1937. Mr. Timm entered the former Department of Mines as an engineer in 1913.

MR. W. L. BARROWS has been elected a director of Messrs. W. and T. Avery, Limited, Soho Foundry, Birmingham.

The Timber Controller has agreed to release MR. COLIN DARBY, to enable him to take up the post of senior Deputy Director in the Home-Grown Timber Production Department. Mr. Darby will work under MR. GERALD LENANTON, the Director, and the transfer will take effect on December 1.

MR. T. F. NASH has succeeded the late MR. W. I. BECKEN as chairman of Messrs. C. Lindley and Company, Limited, bolt and nut and engineers'-tool manufacturers, 34, Engelfield-road, London, N.1.

MR. JOHN BUSSÉ has been appointed by the Board of Trade to be secretary of the Central Price Regulation Committee, 6, Grosvenor-gardens, London, S.W.1. He succeeds MISS M. D. SHUFELDT, who is taking up an appointment with another department.

MR. W. P. HILDRED, O.B.E., Deputy Director-General of Civil Aviation, Air Ministry, since 1938, has succeeded LIEUT.-COL. SIR FRANCIS SHELMERDINE, C.I.E., O.B.E., as Director-General of Civil Aviation. Sir Francis, who retired recently, was appointed to the position in 1934.

MR. JOHN RODGERS has been appointed Director of Post-War Planning in the Department of Overseas Trade. He has been transferred from the Ministry of Information, where he has held the posts of Director of the Commercial Relations Division and, more recently, Adviser on Overseas Planning. Mr. Rodgers' duties at the Department of Overseas Trade will be principally concerned with the investigation of the problems of United Kingdom export trade after the war.

MR. W. W. CONSTANTINE, M.B.E., has been unanimously re-elected for a further period of office as honorary treasurer of the Institution of Automobile Engineers.

LORD MOTTISTONE has accepted nomination by the Council of the Institute of Marine Engineers for election as President of the Institute for the year following the annual general meeting in March next.

MR. C. R. CAMPBELL, hitherto district locomotive superintendent, London Midland and Scottish Railway, Carlisle, has been made district locomotive superintendent at Newton Heath. MR. G. H. NELSON has been moved from Accrington to succeed MR. CAMPBELL at Carlisle, and MR. A. H. MADDEN from Bank Hall to succeed MR. NELSON at Accrington. MR. G. F. HORNE, hitherto assistant district locomotive superintendent at NEWTON HEATH, becomes district locomotive superintendent at Bank Hall.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The amount of new business that could be negotiated on the Welsh steam-coal market was again very restricted during the past week. It was, reported, however, that users in Northern Ireland were to take supplies of Welsh coals. The amount of new business that could be concluded on export account was also very restricted, owing to difficulties in securing the necessary export licences. These were only being issued in respect of the inferior qualities which are in slow request among home users. The exports that are made are chiefly to Eireann, Portuguese, Spanish and South American destinations. There was a keen demand from customers in the home section but only a part of the business available could be arranged. Most collieries already had sufficient orders on their books to ensure a steady outlet for almost the whole of their potential outputs for some time. As a rule, collieries were concentrating upon completing deliveries to the essential war industries and to public utility undertakings, with the result that contracts held by ordinary users were in arrears in some cases. Best large descriptions were still only very sparingly available and were firm. The sized grades attracted a good deal of attention and the dry steam sorts, in particular, were hard to stem and were very steady. The best feature was again provided by the bituminous small descriptions which were extremely scarce. On the other hand, little difficulty was encountered in obtaining early deliveries of the inferior dry steam small sorts, which were dull. Cokes and patent fuel showed no change.

The Iron and Steel Trade.—Activities in the iron and steel and allied trades of South Wales and Monmouthshire were well maintained during the week. There was a steady demand but most works were already fully engaged on contracts in hand.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Sheffield Chamber of Commerce is inviting its members to notify it of any spare capacity. That some concerns have such capacity is indicated by the fact that the Chamber has circulated to its members information regarding certain instances, together with the statement that the firms concerned are willing to undertake any work to which the plant can be applied. Conditions in the raw and semi-finished steel trades show no material change. The bulk of the output is taken by works engaged on Government orders, so that the tonnage available for ordinary commercial customers is very limited. Steel makers are having no difficulty in obtaining sufficient supplies of hematite, pig iron, and steelmaking alloys. Basic steel is in strong demand, and there is a better call for acid steel than was the case three months ago. Production of these materials is being increased at some concerns. Re-rollers are operating at full capacity, and the heavy machinery and engineering trades are very busy on Government work. Steelworks and ironworks machinery and related equipment are in strong demand, and local works are handling some large orders. There is an increased demand for railway rolling stock; wheels, axles, springs, tyres, and buffers are being turned out in larger quantities. The special-steel branches are very active; the demand is steadily increasing, but, as in the case of bulk steels, only a limited amount is available for commercial users. Spring steel is a progressive line, and there is an active demand for magnet steel.

South Yorkshire Coal Trade.—All types of coal are moving freely from this area. Overseas trade shows no sign of improvement, but the inland demand for industrial coal has been more than maintained. Steams, smalls, and slacks are in strong request, and locomotive coal is being ordered in larger quantities. The house-coal market shows a seasonable activity. Foundry and furnace cokes are steady.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been little change in the Scottish steel trade during the past week. Makers are managing to meet all demands promptly. A large proportion of the business on hand is for plates for the construction of ships, tanks and boilers, and the demand for special alloy steel has been steadily increasing. Black steel-sheet makers are actively employed as a large tonnage of light and galvanised sheets is needed. Export business has been greatly reduced and although some good inquiries have been received recently, makers are not in a position to consider them. The following are the current market quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black steel-sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—The West of Scotland malleable-iron makers have a fair amount of work on hand, but are not overtaxed and could produce a larger tonnage if required. Perhaps the most active demand at the moment is from rivet, bolt and nut makers, and this is likely to continue for some time. Wrought-iron scrap is not plentiful, but stocks are sufficient for current requirements. The re-rollers of steel bars are fairly busy, but could handle a much larger tonnage as they are well placed for raw material, having accumulated satisfactory stocks of semies. The current quotations are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—Active conditions continue in the Scottish pig-iron industry and the total output is quickly taken up. Consignments of iron ore have been coming in regularly and ample stocks have been accumulated, so that the outlook is satisfactory from this point of view. There is a steady demand for both hematite and basic iron, and orders for foundry grades show some improvement. To-day's market quotations are as follows:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

SWANSEA METAL MARKET.—The weekly report of the Incorporated Swansea Exchange states that the tin-plate market remains steady; the home demand is good and absorbs much of the production. Galvanised and other steel sheets are in better demand, but some works could cope with further orders. There is a good demand for iron and steel scrap.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Conditions in the iron and allied trades show little change. The market is fairly active though many customers have covered their requirements to the end of the year. Producers are meeting most of their contract obligations but the pressure for larger deliveries of one or two descriptions of material is taxing their resources. A salient feature of the position is the abundance of raw materials and semi-finished products.

Cleveland Iron Trade.—There is no improvement in the supply of Cleveland pig, the output of which continues to be meagre and intermittent; the situation, however, is not at all disturbing. Foundry-iron consumers have no difficulty in obtaining ample deliveries from other producing areas. Most of the iron passing into consumption at North-East coast works is from the Midlands. Buying is still mainly direct from the producers, but slightly increased business is passing through second hands. The official market quotations for Cleveland pig are ruled by No. 3 description at 128*s.* delivered to Tees-side customers.

Basic Iron.—Basic-iron makers are not yet able to offer any tonnage for sale, but are maintaining output at a level which enables them to meet the heavy calls of their own consuming plants. The fixed price of basic iron is 120*s.* 6*d.*, but is nominal.

Hematite.—The changes noticeable in the hematite situation are slight but are very welcome. The supply is still short of the demand, but some further expansion in the make and the increased use of substitutes has relieved the stringent position appreciably. Refined iron is now being used satisfactorily for many purposes for which hematite was formerly considered to be essential. Drastic restriction of distribution, however, is still unavoidable and delivery permits are issued only for essential needs. The stabilised values of hematite remain at the level of No. 1 quality at 138*s.* 6*d.* delivered to North of England buyers.

Foreign Ore.—The delivery of foreign hematite is still difficult to secure, but most other ores from abroad are obtainable fairly freely and consumers have satisfactory stocks.

Blast-Furnace Coke.—Sales of Durham blast-furnace coke are light, but values are firmly upheld. Holders have a considerable tonnage for distribution, but their contract obligations are extensive and they are not pressing parcels on the market, while local users are well covered and are not keen buyers. The recognised market values are ruled by good medium qualities at 36*s.* 9*d.* f.o.r.

Manufactured Iron and Steel.—The tonnage of semi-finished iron and steel stored at the re-rolling mills is still exceptionally high, recent withdrawals having been lighter than was anticipated. Users expect that the deliveries of home products will be sufficient to maintain stocks at a satisfactory level, though consumption is heavy and is increasing. Finished-iron makers are busiest in the departments turning out heavy commodities. In the steel industry, the demand for structural material shows some further improvement, and specifications for shipbuilding requisites continue to receive prompt attention. The increasing demand for special alloy steels necessitates an enlargement in production; black and galvanised sheets are steadily taken up.

Scrap.—Light varieties of iron and steel scrap are fairly plentiful, but the demand for heavy grades is not fully met.

BULK AUTHORISATIONS FOR IRON AND STEEL.—The Ministry of Supply, Iron and Steel Control, has sent us a copy of "Form M (Bulk Authorisations)," issued by the Ministry of Works and Buildings. The Control states that now that the principles of the Iron and Steel Distribution Scheme are well understood, it is felt to be possible to reduce the clerical work involved by making it unnecessary for authorisations to be issued, when placing orders for manufactured articles, in cases in which the manufacturer would require 1 cwt. or less of iron and steel to execute each order. Thus, a supplier of manufactured articles, fulfilling orders each of which involves only small quantities of iron or steel, but who buys appreciable quantities of these materials in the aggregate, will be able to obtain a bulk authorisation by using the new Form M. Further particulars regarding the scheme may be obtained from the Iron and Steel Control, Steel House, Tothill-street, London, S.W.1. The goods, to which the bulk authorisations relate, comprise stoves, grates, baths, metal windows, locks and hinges, latches, and many other items of builders' ironmongery. Applications should be addressed to the Secretary of the Ministry of Works and Buildings (A.S. 69), Lambeth Bridge House, Albert-embankment, London, S.E.1, or to the Assistant Secretary, Industrial Supplies Department, Board of Trade, Millbank, London, S.W.1.

NOTICES OF MEETINGS.

It is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—To-day, 2.30 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. General Meeting. Thomas Hawksley Lecture: "A Century of Tunnelling," by Mr. W. T. Halcrow. *North-Western Branch:* Saturday, November 22, 2.30 p.m., The Engineers' Club, Albert-square, Manchester. "Munitions Labour Supply Organisation," by Mr. W. H. Denholm. (Alteration of date.) *Institution:* Friday, November 28, 5.30 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. Informal Meeting. Discussion on "Practical Vibration Problems," to be introduced by Dr. H. L. Guy.

INSTITUTION OF CIVIL ENGINEERS.—*Yorkshire Association:* Saturday, November 22, 2.30 p.m., The Hotel Metropole, Leeds. Joint Meeting with the *Yorkshire Branch* of THE INSTITUTION OF STRUCTURAL ENGINEERS. A series of short papers entitled "War-Time Expedients."

INSTITUTION OF PRODUCTION ENGINEERS.—*Edinburgh Section:* Saturday, November 22, 3 p.m., The North British Station Hotel, Edinburgh. "Electrical Deposition of Metals and the Anodic Treatment of Aluminium," by Mr. Stanley Murray. *Sheffield Section:* Wednesday, November 26, 6.30 p.m., The Grand Hotel, Sheffield. "The Manufacture of Precision Measuring Tools," by Mr. A. E. Morrison.

INSTITUTION OF AUTOMOBILE ENGINEERS.—*Manchester Centre:* Saturday, November 22, 3 p.m., The Engineers' Club, Albert-square, Manchester. General Meeting. "The Prevention of Accidents, from the Technical Aspect," by Major E. G. Beaumont.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North-Eastern Centre:* Monday, November 24, 6.15 p.m., The Neville Hall, Westgate-road, Newcastle-upon-Tyne. Informal Discussion on "Post-War Planning." *Wireless Section:* Tuesday, November 25, 4 p.m., Savoy-place, Victoria-embankment, W.C.2. Informal Meeting. *London Students' Section:* Wednesday, November 26, 7 p.m., Savoy-place, Victoria-embankment, W.C.2. "Electro-Plating," by Mr. C. V. Taylor.

BRADFORD ENGINEERING SOCIETY.—Monday, November 24, 7.15 p.m., The Technical College, Great Horton-road, Bradford. "The Measurement of Surface Finish," by Mr. C. Jolliffe.

INSTITUTE OF TRANSPORT.—Tuesday, November 25, 12.45 p.m., The Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Lunch-Hour Informal Meeting. "Operating Problems After the War," by Mr. C. F. Klapper.

ROYAL SOCIETY OF ARTS.—Wednesday, November 26, 1.45 p.m., John Adam-street, Adelphi, W.C.2. Ordinary Meeting. "The Post-War Home: Its Interior and Equipment. (i) The Contributory Industries: What Are They and How Can They Help Re-Employment?" by Mr. Howard Robertson.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 28, 6 p.m., The Rooms of the Literary and Philosophical Society, Newcastle-upon-Tyne. "Further Experiments with Models of Cargo-Carrying Coasters," by Dr. F. H. Todd and Mr. J. Weedon.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Friday, November 28, 7 p.m., The Victoria Hotel, Keighley. "Impact and Notched-Bar Testing," by Mr. C. N. Waterhouse.

JUNIOR INSTITUTION OF ENGINEERS.—Saturday, November 29, 2.30 p.m., 39, Victoria-street, Westminster, S.W.1. Ordinary Meeting. "The Engineer and the Rest of the World: A Study in Relationships," by Mr. K. S. Jewson.

THE NEWCOMEN SOCIETY.—On page 373, *ante*, we recorded the election of Mr. E. Lancaster Burne, A.M.Inst.C.E., as President of the Newcomen Society in succession to Colonel C. E. Davies, of New York. At the same meeting, held in London on November 11, the following elections were made of officers and members of Council: vice-presidents, Dr. C. H. Desch, F.R.S. (London), Mr. S. B. Hamilton, M.Sc. (Droitwich), and Mr. James B. Leavell (Chicago, Illinois); members of Council, Dr. Karl T. Compton (Cambridge, Massachusetts), Mr. J. B. Ennis (New York, N.Y.), Dr. Robert G. Sproul (Berkeley, California), Dr. A. P. Thurston (London) and Mr. Rex Wailes (London); honorary treasurer, Mr. J. Foster Petree (Sutton, Surrey). The United States Navy was strongly represented among the 40 new members elected to the Society, the list including the names of Admiral Harold R. Stark, Chief of Naval Operations; Rear-Admiral A. T. Church, Director of the Naval Engineering Experiment Station, Annapolis, Maryland; Rear-Admiral Hay Spear, Paymaster General of the United States Navy; and Rear-Admiral William H. P. Blandy, Chief of the Bureau of Ordnance.

COUPLED RAILCARS FOR THE GREAT WESTERN RAILWAY.

MESSRS. THE ASSOCIATED EQUIPMENT COMPANY, LIMITED, SOUTHALL, MIDDLESEX.

(*For Description, see Page* 419.)

FIG. 1. TWIN-COUPLED RAILCAR UNIT.

THE STORAGE OF RADIUM.

THE question of the safe custody, handling, and transport of radium under war conditions has recently been considered by the Minister of Home Security in consultation with the Minister of Health. In addition to the radium held by hospitals under arrangements with the Radium Commission and King Edward's Hospital Fund for London, there is an appreciable amount of the material in this country in the hands of small hospitals, medical practitioners and commercial firms. Consequently, the Minister of Home Security has decided that, for the protection of the public, it is necessary to bring to the notice of all who have the custody of radium the precautions which should be taken to avoid its dispersal as a result of enemy action and the steps which must be taken in the event of dispersal. It is directed that all radium exceeding 1 mg. in amount and not in actual use should be kept in a borehole or in a steel container of approved type. The borehole should have a depth of about 50 ft., depending on the nature of the sub-soil; it should be lined with steel tubing and the bottom of the shaft cemented. The shaft should have a diameter of 6 in., 8 in., or 10 in., according to the quantity of radium to be stored. At the top of the borehole a concrete, box-like superstructure should be erected to enclose the winch used for raising and lowering the radium receptacle, and a door provided to give access to the handwheel of the winch.

The steel container approved by the Ministry for the storage of radium consists of a block of mild steel which is either circular or square in cross section. A central cavity is bored in the block to receive the receptacle containing the radium, and the entrance to the cavity is sealed by means of a screwed plug. Some allowance should be made for protecting the radium receptacle by lining the cavity with a layer of resilient material such as cork or rubber. The external dimensions of the steel block should be such that the wall thickness around the cavity is not less than 3 in., and the screwed part of the plug should also not be less than 3 in. long. If the block used be cubical, the corners may be rounded off to save weight, provided that the thickness of the steel around the cavity is not reduced below 3 in. For speed in handling it may be convenient to fit to the end of the plug a carrier in which the radium receptacle can be inserted before the plug is screwed into the steel block. Not more than 350 mg. should be kept in any one steel container and this is also the maximum quantity which should be in actual use at any time in a hospital situated in a vulnerable area. Radium should not be sent by post; it should be dispatched either by special messenger or by passenger train, and in the latter case it should be handed to the guard and taken over from him at the destination station. Radium so conveyed, if less than 10 mg. in quantity, should be enclosed in a container lined with lead 3 mm. in thickness. When the quantity conveyed is between 10 mg. and 50 mg., the container should be supported in the centre of a box, the minimum dimensions of which are 1 ft. by 1 ft. by 1 ft.

The Minister of Home Security has also issued precise instructions regarding the measures to be taken in the event of actual or suspected dispersal of radium. Should a bombing incident occur on any premises where radium is known to be in use or to be stored, the occurrence should be notified at once to the Medical Officer of Health, who will arrange for the danger area to be cordoned off immediately after fire and casualties, if any, have been dealt with. The occurrence should then be notified by telephone or telegram to the Minister of Health, Whitehall, London, S.W.1, who will arrange for experts to examine the site and to advise what further action is necessary. It is emphasised that the special precautions outlined above, which are contained in a leaflet issued by the Ministry of Home Security, are not prescribed for the activated luminous compound used in luminous paints though the amount of radium present may exceed 1 mg.

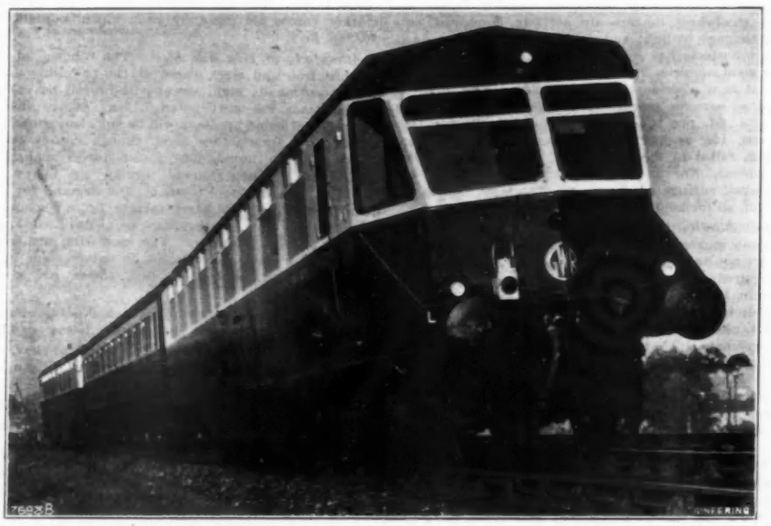


FIG. 2. RAILCAR UNIT WITH CORRIDOR COACH INTERPOSED.

ENGINEERING.

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London, W.C.2.

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ENGINEERING

FRIDAY, NOVEMBER 21, 1941.

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THE EFFICIENT EMPLOYMENT OF LABOUR.

IN their 21st Report, published in August of this year, the Select Committee on National Expenditure made a number of recommendations designed to promote a more efficient utilisation of labour in the production of munitions. Some of these, though not many, related to matters which are still left to the unrestricted option and judgment of employers; but the greater part concerned administrative principles and details which are now governed more or less completely by departmental decisions and the various powers of control that the Government have assumed under the authority of war-time legislation. Several recommendations were briefly discussed in an article on page 171, *ante* (in which, we may mention, the report in question was inadvertently referred to as the 20th); but their number—32 in all—made it impracticable to deal with every one. Evidently, however, they have received close attention from the Government departments concerned, whose comments have been collected and presented to Parliament in the form of another report (the 25th of 1940-1) by the Select Committee. Appended to it is an additional section, describing the principal measures that are in force for providing and training the further personnel, skilled and unskilled, which is now required by the expanding productive capacity of British war industry.

One of the points to which we referred in the article previously mentioned was the recommendation that more accurate data should be kept—and, which is even more important, should be systematically used—regarding the output per individual, as a check on the prevalence of lost time and the causes of reduced productivity. To this the official reply is, quite reasonably, that it is impracticable to keep such a detailed record in respect of all establishments; but it is recognised that a closer watch should be kept on records of output, labour wastage, absenteeism and idle time. To this end, steps are being taken to carry out special investigations of particular plants and to check over the records already kept. No doubt, some improvement will be effected by these means; though it must still remain fundamentally true that the most economical method of achieving efficiency in these directions is by the exercise of proper supervision by the works officials on the spot. In time of war, however, when so much depends on external factors such as Governmental control of supplies and of priority, and when some dilution is inevitable within the managements themselves, a reduction in the quality of internal supervision seems to be inevitable. The best that can be hoped for is that some of the more obvious sources of wastage shall be eliminated, and that the investigation itself shall not unduly disorganise production.

Considerable attention was devoted in the 21st report of the Select Committee to the questions of hours of work, both of the employees and the plant, and a correspondingly prominent place is taken in the 25th report by the replies. The departments agree in endorsing the view that, under war conditions, they should assume a wider responsibility for the hours of work in the establishments of Government contractors, and should give definite instructions accordingly, in agreement with the Ministry of Labour and National Service. The Industrial Health Research Board, it is stated, have carried out a number of investigations to determine the best length of a working week; and these indicate that, over extended periods, the weekly hours of work should not exceed 60 for men, and 55 for women. It is proposed to obtain further information regarding conditions in certain particular sections of industry and on special kinds of work; but, in general, it appears desirable that steps should be taken to stabilise hours of work within the limits mentioned.

On the broad principle that one day's rest in seven should be provided, the Committee had observed that this issue had been confused by considering it purely as a question of Sunday labour. The official comment is that, for reasons of practical operation, 5½ days or 6 days of production, with or without two-day shifts or day-and-night shifts, is likely to continue to be the best system that can be arranged. The additional labour force required for a continuous rota system has to be taken into account, and the possible increase in volume and efficiency of production must be carefully investigated, to be sure that this is the best way to employ the additional labour. The nature of the work, the provision of supervisory staff, and the extra demands made upon transport systems by Sunday work are other significant factors. Taking all of these into consideration, the departments maintain that Sunday work in general should be restricted to such essential maintenance or repair work as cannot well be done at other times, with occasional exceptions to meet emergencies.

The suggestion, put forward by the Select Committee in their 17th report, issued in July, that the reduction of earnings, likely to result from the abolition of Sunday work, might have to be compensated by some adjustment of time rates, is disposed of summarily in the Government reply. It appears that this suggestion has been actually put forward by employees in a Government establishment as ground for a demand that, if Sunday work is abolished, time rates should be increased. "The granting of compensation for loss of earnings owing to the abolition of overtime," the reply states roundly, "would be contrary to all established principles for the fixing of remuneration"; moreover, "the main object of trade unions in insisting on extra payment for Sunday and Bank Holiday work is to restrict work on that day to a minimum." For these reasons, the Government are unable to accept any suggestion that such extra payment should be taken into account in fixing wages for week-days. As a statement of principle, this is definite and reasonable enough; though it is, perhaps, stretching the point to read into it any belated admission on the part of the Prime Minister that his critics of the last war were right in condemning the 12½ per cent. increase which, as Minister of Munitions in 1917, he gave to time-workers to bring their earnings nearer to parity

with those of piece-workers. It might have been well if some equally definite pronouncement had been made, when the Government assumed their present direction of industry, to restrict sectional applications by individual trades for "lieu rates."

These problems, and the associated question of the reductions that are occasionally necessary in piece rates, were evidently in the minds of the Select Committee when they recommended that consideration should be given by the departments to devising arrangements for the adjustment of piece rates that will not discourage improvement of the rate of output. The reply points out, as we have done on more than one occasion, that it is always difficult to ensure the right fixing of piece rates, especially under war-time conditions; but gives an assurance that the matter is constantly under consideration by the production departments, and that their influence is exercised to secure that piece rates shall be fixed on a fair basis within the terms of existing industrial agreements. Wherever possible, contracts are now placed on a fixed-price basis and, where this cannot be done, labour costs that appear to be high as a result of bad ratefixing are separately investigated. This assurance is naturally welcome; but such investigations take time, and their effect cannot always be made retrospective.

Various recommendations were made by the Select Committee, arising out of complaints that employees were being kept in a state of compulsory idleness. It was appreciated by the Committee that there might be many reasons to account for a temporary and local lack of work, and that these might not be within the competence of the employer to remedy. It was suggested that managements should take the workpeople more fully into their confidence on such occasions and should explain the causes which have led to the unemployment; also, that more might be done to arrange for any temporary surplus of labour to be transferred to other works in the neighbourhood, subject to assurances that they will be returned when normal activity can be resumed in the works where they were originally employed. Such proposals seemed, at the time, to indicate an insufficient acquaintance with ordinary industrial conditions, and it is not surprising to find that, as regards the proposals for temporary transfers of surplus labour, the official reply shows an indisposition to apply any compulsion in this respect. Apart from the increased clerical work that is inseparable from the short-term employment of such virtually casual labour, and the interference with supervisory and administrative arrangements that would be involved, a certain time-lag is inevitable before a newcomer to a particular works or process can attune himself to his new surroundings and reach the normal level of production. This time-lag will naturally vary with the individual and the character of the work, but in many cases it may be sufficient, when taken into account with the other disturbing factors, to reduce materially the productive benefit that might appear to be theoretically possible in making the transfer.

Obviously, such an arrangement would be applicable only to stoppages of very brief duration, and there are some causes of idle time which, by their nature, cannot be speedily overcome; for example, the interruption of production that results when an aircraft factory turns over to the construction of some new type of machine cannot be entirely avoided or even greatly reduced. In such circumstances, it would be an advantage to be able to transfer employees elsewhere, and many of them could probably be spared for a period of months; but they would not be releasable all at once, nor would they be required to return all at the same time, and the work of maintaining touch with each individual in a labour force of any size is in itself a considerable task. The reply of the departments indicates that the force of these and similar arguments is being learned by experience. Arrangements have been made, it is stated, for joint investigations into the labour needs of factories by representatives of the Ministry of Labour and the appropriate production departments, and there is no question that the amount of idle time is now considerably reduced by comparison with some previous periods during the war. In practice, it is recognised, such loss cannot be entirely eliminated.

THE ALASKAN INTERNATIONAL HIGHWAY.

Alaska, that northern outpost of the United States, is at present connected to the motherland only by sea and air, although a glance at a map of North America will show that, as the crow flies, the southernmost tip of the territory is but 500 miles from the nearest point in the State of Washington. There is nothing novel in closely-associated communities depending on sea transport for their inter-connection, but in the case of Alaska and the United States conditions are unusually difficult. The former, apart from the narrow strip running down the coast of Canada, is roughly a square with sides 1,000 miles long. Owing to the formation of the littoral, however, which is made up of inlets, bays and islands, the coast line is 26,000 miles long. More than half of the population is concentrated in the south-eastern coastal strip, in which the capital, Juneau, is situated, and here the sea approaches are narrow and particularly difficult. So broken is this Pacific shore that it is known as the Alexander Archipelago. The majority of the islands and narrow promontories are uninhabited and seldom visited.

The difficulties due to the geographical formation are added to by climatic conditions, particularly in the winter. Rain, fog, snow and sleet are common, and navigation of the rocky channels, dangerous at the best of times, becomes hazardous. Two vessels of the regular steamship service to Alaska have run on to the rocks in the last twelve months, and the United States transport Kvichak was completely lost. The territory is practically dependent on outside supplies for its means of existence and its present relative isolation is a matter of much concern. Although an air service provides an additional connection with the United States, this does not, and cannot, constitute the link necessary for normal commercial activities. The position which is unsatisfactory in peace time, has become much more so in war. Navigation requiring the greatest care even under the best conditions might become impossible were it subjected to the activities of enemy submarines, and, quite apart from direct operations in the Alaskan seas, the call for shipping elsewhere, owing to the wholesale destruction now proceeding, might render it impossible to maintain the present services and leave the territory completely isolated.

It is in these conditions that the project for the construction of a highway linking the United States with Alaska has been brought forward. The Alaskan International Highway Commission, made up of representatives of the United States and Canada, has recommended that such a road should be put in hand at once. It estimates that the road could be completed in two years. The road would, naturally, be as much of Canadian as of United States concern, and actually more than 1,000 miles of its total length of 1,420 miles would be in Canada. There was a time when the delimitation of the boundaries between Alaska and British Columbia and Yukon was a matter of acute controversy between British and United States interests, but there is now no probability of political friction arising in connection with such a work of mutual interest as the projected road. The peace-time needs of Alaska require the existence of a transport service with a capacity of 600,000 tons a year. Military necessity it is considered might raise this figure to 1,000,000 tons. The projected road is assumed to be of a type suitable for accommodating heavy traffic and although it is clear that these are high figures for lorry transport on a single road, the value of such a road in case of interruption of shipping services is equally obvious.

The planned route connects Prince George in British Columbia with Fairbanks in Alaska. Both these termini are already well served. The United States Ladd Field Military Air Base is situated at the latter place, which is connected by road with the port of Valdez. It is also the terminus of the Alaska Railroad. At the eastern end, construction would have to be carried only to Fort St. James, some 80 miles from Prince George. This place is served by a spur road branching from the Prince George-Hazelton road. Prince George is connected by road with Vancouver and is also on the Canadian National Railway from Edmonton, which links it with Hazelton and so with Prince Rupert on the Pacific.

The road would lie roughly parallel to the sea and would be situated behind the ranges of costal hills in a semi-arid region. In view of the general characteristics of the Alaskan climate, the precipitation in these areas is surprisingly low. For the first 1,000 miles of the route, from Fairbanks at the western end, there is an average during the winter months of 2 ft. of very light snow. In limited areas, depths of 3 ft. to 4 ft. may be reached. Farther east, where the road would at one point rise to an elevation of 4,400 ft., between the basins of the Stikine and Skeena Rivers, greater depths of snow may be encountered, but these will not exceed 6 ft. From November to April the road will be frozen hard and will provide an entirely practicable surface. Construction would be relatively simple. For the first 600 miles from Fairbanks, there would be only 6,000 cub. yds. of rock to be cleared, the formation in this area being loess mixed with sand, silt and gravel. For more than 700 miles, the route lies adjacent to rivers, lakes or existing low-grade roads, and the general cross section of the country is flat. These conditions would facilitate construction, and it is estimated that more than half of this part of the road could be made for 10,000 dols. a mile. From mile 740 to mile 950, the Canadian engineers consulted estimate the cost at 14,000 dols. a mile, this figure, however, including a figure of 300,000 dols. for the building of a bridge over the Stikine River. This would be the only important bridge on the road. Allowing for administrative and other expenses and connection to existing roadways at each end, the Commission suggests a conservative total figure of 20,000 dols. a mile for the whole road.

The estimates are based on a gravel road 24 ft. wide and 40 ft. between side ditches. Gravel is easily available practically throughout the entire route. The suggestion that the work could be completed in two years is based on Canadian and Alaskan road-building experience. This has shown that a crew of 30 men can complete from 12 miles to 16 miles of roadway in one season. On this basis 60 crews, or 1,800 men, would have to be employed and supplied with suitable road-making equipment. The whole of the projected route of the road has been traversed by observers, and the Canadian and American engineers who have reported have covered at least 90 per cent. of the length on foot. Various spur roads linking-up outlying towns, including Dawson, in Yukon, are suggested, but are not covered by the estimate.

At the present time it takes seven or eight days for material to reach Fairbanks from Seattle, travelling by boat and rail. With the road in being it could be transported from Prince George in 60 hours. In case of military operations this difference might be vital. Prince George is 525 miles north of Vancouver and, as already mentioned, is linked to it by rail and road. In so far as the matter is looked upon as a defence measure, it would no doubt be necessary for the United States Army to establish a supply depot at Prince George, if full benefit is to be drawn from the facilities provided, but it would not appear that this would present difficulties at the present time. The construction of the road would also greatly assist in the development of the air service. In spite of the absence of beacons and airfields, the air services connecting British Columbia and Alaska already follow a route closely parallel to that of the proposed road. They cover a stretch of 600 miles which contains neither roads nor emergency landing grounds. The highway would open up the country, facilitate the construction of aerodromes, and would enable them to be kept supplied. It would also provide a guiding ribbon through the broken country. Although, not unnaturally in view of the present circumstances, the case for the road is being argued largely on military grounds, it is clear that its commercial and social possibilities would be great in opening up a large area now almost inaccessible. Its construction would form an excellent example of that international co-operation in large constructional works, which one may hope to see extended in the future.

NOTES.

H.M.S. "ARK ROYAL."

THANKS largely to German broadcast propaganda, the aircraft-carrier Ark Royal occupied a particularly prominent position in the minds of the British public, and the news, announced by the Admiralty on Friday last, that she had sunk after a torpedo attack on the previous day, created a correspondingly profound impression, which was not lessened by recollections of the heavy loss of life that had accompanied the sinking of the older and smaller aircraft-carriers Courageous and Glorious. Happily, fears on the latter score proved to be unfounded, the whole of the ship's company being rescued with the exception of one man, who appears to have been trapped below. Even the loss of the ship, serious as it is, is much less crucial than it would have been in the opening stages of the war; several, if not all, of the Illustrious class of six carriers which were under construction at the outbreak of hostilities are now in service, and the Ark Royal herself, during her comparatively short career, has accomplished more than enough good work to represent a handsome return on her considerable first cost. If there are any who still feel, as many experienced critics of naval policy did feel, not so many years ago, that the heavy outlay involved in providing a fleet of aircraft-carriers might have been better utilised in other directions, her record of service is surely a sufficient answer. The Ark Royal was laid down in September, 1935, at the Tranmere shipyard of Messrs. Cammell Laird and Company, who also constructed her propelling machinery. She was 800 ft. long overall, with a beam of 94 ft., and displaced about 27,000 tons in sea-going condition. Her four-shaft Parsons geared turbines developed 103,000 shaft horse-power on trials, giving a speed of 31¼ knots. She was launched on April 13, 1937, the naming ceremony being performed by Lady Maude Hoare, wife of Sir Samuel Hoare, then First Lord. An account and illustration of the launch appeared on page 472 of our 143rd volume. It was observed at the time that welding had been extensively employed in the construction of the hull, but to how great an extent this was done was not generally appreciated until the Spring Meeting of the Institution of Naval Architects in 1939, when a paper on the vessel was read by Sir Stanley V. Goodall, the Director of Naval Construction.* The Ark Royal was in service from the earliest days of the war, and was heavily attacked by German dive-bombers in September, 1939, when serving in the Home Fleet. She was not hit, but escaped by so narrow a margin that the Germans claimed to have sunk her and decorated the pilot who was supposed to have done so. Subsequently she took part in the hunt for the Graf Spee and in the naval air support provided for the operations in Norway. In July, 1940, she was sent to the Mediterranean, as a unit of the highly mobile force under the command of Vice-Admiral Sir James Somerville. She was ordered into the Atlantic to assist in locating the German battle-cruiser Bismarck, and it was her aircraft which succeeded, on May 26, in torpedoing the German ship and reducing her speed sufficiently to enable the other British warships to surround and sink her. Addressing the crew of the Ark Royal at Gibraltar after their rescue, Captain L. E. H. Maund, who had commanded her, stated that she had steamed 205,000 miles and had been engaged in 32 war operations.

THE HOLMES CHAPEL COLLISION.

The collision which took place in the early hours of September 14, 1941, at Holmes Chapel station, on the Crewe to Manchester line of the London Midland and Scottish Railway, was briefly reported on page 233, *ante*, but no details were available at that time to suggest a possible cause. These particulars have now been supplied in a report by Colonel A. C. Trench, R.E., Assistant Inspecting Officer of Railways, to the Director-General of the Ministry of War Transport. The trains involved were the 12.35 a.m. express passenger train from Crewe to Leeds, which was just moving away from a stop at the Holmes Chapel home signal, and the 12.50 a.m. express passenger train from Crewe to Manchester, which, at 1.23 a.m., overtook and collided with the Leeds train when running at a speed of 30 to 35 miles an hour. The engine of the Manchester train telescoped the last coach of the Leeds train and also wrecked the two in front of it. The engine and the leading two coaches of the Manchester train were damaged, the coaches seriously; the third coach was derailed; and the other vehicles of this train all sustained some damage. Six passengers were killed and three more died from their injuries; 21 passengers were detained in hospital, and 24 other persons required treatment, but were not detained. The line from Crewe to Manchester runs approximately north and south and is practically straight, except for a slight curve to the right in the approach to Holmes Chapel. The signal boxes concerned, in order from Crewe, are Sandbach, Bradwall, Holmes Chapel, and Goostrey. Bradwall box is an intermediate block post, only in use at night, when there is heavy goods traffic. Colonel Trench, in his report, found it clearly proved that responsibility for the accident was attributable either to Signalman Miller at Bradwell or to Signalman Perks at Holmes Chapel, or to both. Miller maintained that he had seen the tail lamp of the Leeds train and had received "Out of Section" for that train before offering the Manchester train to Perks; but he admitted that he could not remember the block instrument indicating "Train on Line" for the Leeds train or going back to "Line Blocked" after it had supposedly passed Holmes Chapel, and that he had been reading a book in the signal box. The driver of the Manchester train, being on the left-hand side of the cab, did not see the tail lamp of the Leeds train; and his fireman, who had just finished firing, was temporarily dazzled by the glare from the firebox and so he also did not see the tail lamp. The conclusion drawn by Colonel Trench was that Miller had failed to send "Entering Section" for the first train, and that he must, therefore, bear the main responsibility for the accident.

SPARE PARTS FOR CIVILIAN MOTOR VEHICLES.

The Minister of War Transport has announced that certain spare parts for civilian motor vehicles will only be issued if a Certificate of Need is completed, the object being to regulate the delivery of parts in limited supply. This certificate is a declaration by the repairer or agent that certain spare parts are required for use in the repair of a particular vehicle which is already immobilised or is about to be immobilised. The certificate is also a declaration by the owner or operator of the vehicle that it is the only application which is being made for the parts in respect of that vehicle. When completed, the Certificate of Need is sent forward by the repairer, together with the order for the parts, through his supplier to the manufacturer's agent. The latter, if unable to supply the parts in question, forwards the certificate to the manufacturer of the components concerned. No official endorsement of the certificate is necessary. If the manufacturer cannot meet orders for which Certificates of Need have been completed, and, moreover, cannot promise delivery within 21 days, he will return the certificate, with a notification of the estimated delivery date, to be passed on to the operator. If the latter so desires, and if his vehicle is engaged on important national work, he may then apply for Government assistance to the appropriate Regional Maintenance Officer (Certifying Officer) of the Ministry of War Transport. This officer, on presentation by an operator of a returned Certificate of Need in respect of essential vehicles, may pass a spares-shortage certificate to the Ministry of Supply. This certificate consists of a request for special assistance in securing parts which have not been obtainable through the normal trade channels. Civilian operators of vehicles in Northern Ireland should note, however, that if they require Government assistance in respect of returned Certificates of Need, they should apply to the Ministry of Home Affairs and not the Ministry of War Transport. With regard to engines, it is pointed out that operators desiring to obtain a new or reconditioned engine without returning the old unit in exchange should apply, in the first instance, to the Regional Maintenance Office for assistance, as manufacturers will not release engines without exchange, except on Government authority. Certificates of Need will not be required by manufacturers for wheels or tyres, but, in cases of difficulty, the Regional Maintenance Officer will be prepared to assist operators. Supplies of Certificates of Need are available on demand at the various Regional Transport Commissioners' offices of the Ministry of War Transport.

ELECTRICAL INSTALLATION WORK IN WAR TIME.

THERE is general realisation of the fact that labour and material shortages require that normal practice in many classes of engineering work must be abandoned for the present. This is exemplified by the action of the British Standards Institution in introducing various war-time specifications. Electrical installation work is an excellent example of a sphere in which considerable simplification may be achieved without important decrease in efficiency and safety, although possibly with some sacrifice of appearance. The Installations Section of the Institution of Electrical Engineers, attaching considerable importance to this matter, arranged for it to be dealt with in an informal discussion on November 13. The subject was introduced under the title "Solving Wartime Electrical Problems," the opening remarks being made by Mr. A. G. Ramsey. One of the irritating difficulties with which the installation engineer has to contend is a serious shortage of flexible cords and cables. These materials are so extensively used for lighting installations that their non-availability may necessitate considerable departure from normal procedure. Mr. Ramsey suggested the obvious expedients of restricting the use of flexible pendants as far as possible, and placing lighting units near the ceiling in order to eliminate the suspending cords. These are procedures which fall within the sphere of anyone arranging a wiring system, but the further proposal that fittings should be designed to take hard V.I.R. cable instead of flexible cord is a matter for manufacturers. Under present conditions the proposal may well be given consideration, but nevertheless this is obviously a time at which alterations in design and manufacturing procedure should be restricted as far as possible. These opposing considerations may not be incapable of reconciliation in view of some figures given by Mr. Ramsey. He stated that one maker produces 150 different types of ordinary household switch and another 80 types; one firm makes 65 different models of switch plug and another 140; while of lampholders, one maker offers 175 different types and another 50. These large ranges, one may well suppose, are not produced for technical reasons, but, in the main, in order to conform with various schemes of decoration. It is probable that many have already been temporarily abandoned, but even now large ranges are probably being manufactured. By restricting these drastically it might be possible to produce models adapted for use with V.I.R. cable and yet simplify the manufacturing problem as a whole. Mr. Ramsey also suggested that, in general, the practice of running cables in conduit should be abandoned and that wiring should be run in the open on porcelain supports. This practice, somewhat alien to the standards usually aimed at in this country, is common in some parts of the Continent, and there seems no reason why it should not be more extensively adopted here. The suggestion clearly has relation to Mr. Ramsey's proposal that the I.E.E. Regulations for three-months life of temporary installations should be extended to three years. To simplify wiring layouts, the greater use of group, instead of individual, switches and general as against local lighting is recommended. Not unnaturally, some possible war-time measures desirable from one point of view are objectionable from another. The suggestion that in stores and warehouses, lighting should be confined to gangways and loading bays may not always be consonant with the demand for maximum productivity in every department of every works.

* See ENGINEERING, vol. 147, page 386 (1939).

RESEARCH ON CAST IRON.

As is the case with other industrial research organisations, the British Cast Iron Research Association is now mainly engaged on work arising directly out of the war. The programme of research includes an investigation of native iron ores, in order that the fullest use may be made of them during the present national situation, and work on this is being actively carried on. The most readily accessible ores occurring in this country are phosphoric in character and in order to extend the utilisation of phosphoric iron in the foundry three lines of approach are under investigation. The first is to increase the production and augment the use of refined irons made, in part, from phosphoric material, and the second is to employ cast iron containing phosphorus up to the highest limits set by considerations of mechanical strength and soundness. The Association, in its earlier work, had already covered part of this ground; it was recently completed and a report on plain cast irons containing phosphorus has been issued through the Institution of Mechanical Engineers' Research Committee on High-Duty Cast Irons for General Engineering Purposes. This report* indicates the extent to which phosphorus can be used in irons required to comply with given national specifications. The same committee has issued another report, prepared by the Association, on special-duty austenitic and martensitic cast irons, for the information of engineers and designers. Further reports on phosphoric alloyed high-duty cast irons and on alloyed cast irons in general are in preparation.

The third line of approach consists in the dephosphorisation of phosphoric pig and scrap, but the problem of removing the phosphorus without also eliminating the carbon present offers considerable difficulties. It is stated, however, in the twentieth annual report of the Council of the Association for the year ending June 30, 1941, which report was presented at the annual general meeting held in Birmingham on November 12, that much experimental work has been done during the year and that a report on this work has been prepared. A great measure of success has been achieved on the necessarily small-scale trials so far carried out and the subject is now at the stage of justifying practical manufacturing-scale trials. The results hitherto obtained show that phosphorus can be removed with comparatively slight reduction in the carbon content but that there is an accompanying slight loss of manganese and a considerable loss of silicon. These two elements, however, can be subsequently added again to the dephosphorised metal.

For the time being the work done on cast irons containing very fine graphite structures has been postponed, but a group of reports has been prepared in which the stage reached has been recorded, so that the subject can be taken up again at some future date. It is stated that the possibilities of obtaining the fine-graphite iron from the cupola are now much greater than they were, owing to a better understanding of the factors governing graphite formation. Work on the determination of non-metallic inclusions in pig iron and cast iron has been continued and the methods evolved are being applied to a representative series of British pig irons. The researches on the properties of ingot-mould material at ordinary and elevated temperatures is proceeding and the work carried out to extend the life of ingot moulds is proving of great service under present conditions The staff and the laboratory concerned with moulding sands have been very fully engaged during the year under review and, among other work, experiments have continued on the reclamation of oil-bonded core sands and on substitutes for imported clays and other foreign foundry materials. The Joint Committee of the Association and of the Institute of Vitreous Enamellers has continued its activities. An acid-resistance test for finished enamel ware has been devised and work begun on a test for the measurement of the adhesion of vitreous enamel on iron. An investigation on opacifiers, conducted in conjunction with the Tin Research Institute, is in progress and the first report is in preparation.

* See ENGINEERING, page 118, *ante*.

LETTER TO THE EDITOR.

THE CONSTANTS OF STRAIGHT-LINE LAWS.

TO THE EDITOR OF ENGINEERING.

SIR,—It may be of interest to compare the results of Mr. Freeman's ingenious method of computing the parameters characterising the "best" straight line through a set of observational points, as explained in your issue of October 31, on page 354, with those obtained by the straightforward application of the "least squares" criterion to the case where both the x and y observations are liable to error.

Let $(x_n\ y_n)$ denote a representative observational point and let p be the number of the observational points. Then denoting by

$$m_y = \frac{p\,\Sigma_1^p x_n y_n - \Sigma_1^p x_n \Sigma_1^p y_n}{p\,\Sigma_1^p x_n^2 - (\Sigma_1^p x_n)^2},$$

the slope of the line obtained by considering the abscissa values to be free from error, and by

$$m_x = \frac{p\,\Sigma_1^p y_n^2 - (\Sigma_1^p y_n)^2}{p\,\Sigma_1^p x_n y_n - \Sigma_1^p x_n \Sigma_1^p y_n},$$

the slope of the line obtained by considering the ordinate values to be free from error, the slope m_{xy} of the line corresponding to the case in which x and y are both equally liable to error will be given by

$$m_{xy}^2 - \left(m_x - \frac{1}{m_y}\right) m_{xy} - 1 = 0,$$

so that

$$m_{xy} = \tfrac{1}{2}\left\{\left(m_x - \frac{1}{m_y}\right) \pm \sqrt{\left(m_x - \frac{1}{m_y}\right)^2 + 4}\right\}.$$

Substitution of Mr. Freeman's values

$$m_x = 0{\cdot}62_2,\ m_y = 0{\cdot}60_6$$

gives $m_{xy} = 0{\cdot}61_2$ assuming, as is presumably intended, that the values of x and y are to be regarded as including two significant figures. The value of c_{xy} is given by

$$c_{xy} = \frac{1}{p}(\Sigma_1^p y_n - m_{xy}\Sigma_1^p x_n),$$

substitution in which gives $c_{xy} = 1{\cdot}4_4$.

If the weight attaching to x is ω times that attaching to y the equation determining the slope of the corresponding line becomes

$$m^2 - \left(m_x - \frac{\omega}{m_y}\right) m - \omega = 0,$$

so that

$$m = \tfrac{1}{2}\left\{\left(m_x - \frac{\omega}{m_y}\right) \pm \sqrt{\left(m_x - \frac{\omega}{m_y}\right)^2 + 4\omega}\right\},$$

while

$$c = \frac{1}{p}(\Sigma_1^p y_n - m\,\Sigma_1^p x_n).$$

Mr. Freeman's procedure, involving as it does the multiplication of the values of x by 0·6, in effect alters the weighting of the x observations in relation to the y observations, and, in fact, makes $\omega = (0{\cdot}6)^2$. Substitution of $\omega = 0{\cdot}36$ in the above equations then yields the values $m = 0{\cdot}61_6$, $c = 1{\cdot}4_3$, agreeing very closely with the results obtained by the "tilting axis" method.

The suggestion that the weighting of observations may be "casual" is not to be recommended. Unless the method of weighting can be founded on a more rational basis than personal bias it is better to abstain from weighting altogether. The combination of observations of different estimated orders of accuracy may occasionally have to be resorted to in a purely observational science, such as astronomy, but the temptation to do likewise in an experimental science is one to be resisted. The experimental scientist having "arbitrarily decided that certain points obtained by one method are probably inferior in accuracy to others obtained by a second method by, say, 50 per cent." would hardly be justified in seeking to combine them. He would be better advised to regard the results of inferior accuracy in the light of preliminary measurements obtained in the course of developing his experimental technique and to exclude them from consideration in arriving at the final result.

Yours faithfully,

G. F. HERRENDEN HARKER.

Cardiff.

November 2, 1941.

OBITUARY.

DR. W. L. R. EMMET.

WAR-TIME conditions, no doubt, are partly responsible for the fact that it is only recently that we have learned of the death, on September 26, at Erie, Pennsylvania, of Dr. W. L. R. Emmet, the distinguished engineer who was connected for so many years with the General Electric Company at Schenectady.

William Le Roy Emmet was born at Pelham, New York, on July 10, 1859, and was the fourth of ten children. He had some family connection with engineering, his father having been engaged for many years in sugar refining, while his mother was a granddaughter of Josiah Parson, for whom it has been claimed that he was the first man in America to manufacture screws by machinery. William Le Roy, however, showed no marked inclination for mechanical pursuits in his early years and did little to distinguish himself during his school days, which were spent at first near his home and subsequently in Canada, at Lennoxville, Quebec; at New Rochelle, New York; and at the Maryland Agricultural College. He seems to have had no special leaning towards any particular walk of life, but was entered at the Naval Academy at Annapolis in 1876, whence he graduated eventually as a cadet midshipman in 1881 and was appointed to the "sloop" Essex. Though classed as a sloop, a term which the United States Navy interprets differently from British practice, the Essex was a barque-rigged vessel of nearly 1,400 tons displacement, with engines of 800 h.p.; but these do not appear to have exerted any influence on his ultimate career, and it was with no thought of engineering that he left the Navy in 1883.

During the next five years, Emmet held various posts, none of any magnitude. He worked as a tracer in an architect's office, as a salesman, and as a clerk on the Erie Railway, and eventually was engaged by the United States Illuminating Company, of New York, with whom he spent a year repairing arc lamps and other apparatus, at a weekly wage which never reached 10 dols. However, it revived an interest in electricity which he had first felt while at the Naval Academy, and led him to study the subject more intensively, and then to seek a post with Frank J. Sprague, who had been his contemporary at the Academy and was already becoming known as a pioneer of electric traction. In 1888, he joined the Sprague Electric Railway and Motor Company, and soon demonstrated an unusual grasp of the essentials of the design of electrical machinery. He remained with this firm for two years, introducing a number of improvements—on his own responsibility and usually without his employers' knowledge—in the winding, insulation and protection of motors, and the design of overhead trolleys. Being doubtful about the construction of 120 motors supplied for an electric railway at Allegheny, he rebuilt them to his own satisfaction, using (for the first time) varnished cambric for the insulation; an undertaking of which the Sprague Company only became aware when, some time later, the freedom from breakdowns of these motors, by comparison with others which they had supposed to be similar in design, led them to investigate the cause.

In 1890, the Sprague Company was acquired by the Edison Company, but by then Emmet had gone to the Westinghouse organisation; only for a short time, however, as, in the following year, he left to become engineer of the Buffalo Railway Company. There he employed his leisure in designing a new railway motor which attracted the attention of the Edison Company, who gave him an appointment on the staff of the Edison General Electric Company in Chicago as construction engineer on a large number of lighting and other contracts then in hand in the Middle West. Shortly afterwards, when the General Electric Company was formed by amalgamating the interests of the Edison General Electric and the Thomson-Houston Companies, Emmet was moved to New York, but in 1894 he was transferred to Schenectady and thenceforward was more directly concerned with the manufacturing side of the joint business, with central station work,

and with the development of alternating-current plant.

At Schenectady, Emmet was brought into close contact with Steinmetz, Eskil Berg, Rice, and the other outstanding electrical pioneers of the General Electric Company, and with them was intimately concerned with the early plans for hydro-electric developments at Niagara Falls. Although the first contract for generators at Niagara went to the Westinghouse Company, the General Electric Company secured a large amount of work for the intending users of the current generated, including the aluminium plant of the Pittsburgh Reduction Company, and the equipment of the Carborundum Company's works. Both of these installations required transformers of exceptional size, by the standards of the time, and Emmet was responsible for various features of their design. The Niagara Falls Power Company offered him the position of engineer of their plant, but this he declined, preferring manufacture and design to work of a more administrative character. In the development of alternating-current machinery he found ample scope; for example, in conjunction with E. M. Hewlett, he carried out a long series of experiments on switchgear, from which were evolved types of oil switches which were soon widely adopted.

In 1898, on the outbreak of the Spanish-American War, Emmet volunteered his services to the United States Navy and received a commission as navigating officer of a fleet collier; but, on the conclusion of hostilities, he lost no time in returning to Schenectady, and was soon deeply engaged again in power and distribution schemes in various parts of the United States. A year later, however, he was transferred to the turbine department of the General Electric Company and, with C. G. Curtis, and Oscar Junggren, he concentrated all his energies on the design and construction of the large vertical turbo-alternators for Chicago and Newport which provided the foundation for what soon became a new and flourishing industry. In this field again, his name is associated with a number of improvements, including carbon packing, mica-tape insulation, various advances in the cooling of alternators, and the fabrication of stator frames by electric welding. It is doubtful, however, whether any of these attracted such wide attention as his successful efforts to introduce electric propulsion for ships.

Emmet himself has left it on record that he strove for seven years to induce the United States to look favourably on electric propulsion before eventually it was decided to adopt this drive in two of three fleet colliers. Originally, the intention was to fit only one, the Neptune, with electric drive, the order for which was placed with the Westinghouse Company. Learning of this, he at once approached the naval authorities, and succeeded in obtaining for the General Electric Company the contract to equip the sister-ship Jupiter (since reconstructed as the aircraft-carrier Langley). The third ship, Cyclops, was fitted with steam reciprocating engines. The three ships went into service in 1913 and, as is well known, led to the adoption of electric drive in some of the largest ships in the United States Navy; culminating in the aircraft-carriers Lexington and Saratoga, the machinery of which has developed over 200,000 shaft horse-power.

Emmet's interest in the mercury-vapour boiler dates from 1913. The idea of the binary-fluid system of steam generation had been previously patented by C. S. Bradley, to whom he suggested the use of mercury; the proposal did not appeal to Bradley, however, and Emmet proceeded to develop it independently. The system has been described on many occasions, by Emmet himself, and by his collaborators and others. Many experimental boilers were constructed before the first commercial set was installed, this being for a 10,000-kW unit at the South Meadow station of the Hartford Electric Light Company, Hartford, Connecticut. It was put into regular service in February, 1930.

Mr. Emmet was a man of very wide interests, and was the recipient of many marks of distinction, including the honorary degree of D.Sc. from Union College and from Trinity College; but the title of "Doctor" was one for which he had little liking. He was probably more proud of being, as he has recorded, "called Uncle Bill by a considerable section of the population of Schenectady and several other places." He was a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Society of Naval Architects and Marine Engineers, the American Philosophical Society, and the National Academy of Sciences. At the St. Louis Exposition of 1904, he was awarded the Gold Medal for his part in developing the vertical steam turbine. A similar award was made to him at the San Francisco Exposition in 1915 in recognition of his work on electric propulsion of ships; and he was also a recipient of the Edison Medal, the Elliott Cresson Medal, and the Gold Medal of the American Society of Mechanical Engineers.

MR. C. F. BUDENBERG.

It is with regret that we note the sudden death on November 12, at his home at Marple, Cheshire, of Mr. Christian Frederick Budenberg, senior partner in the firm of Messrs. Budenberg Gauge Company, Limited, pressure-gauge manufacturers, Broadheath, Altrincham, Cheshire. Mr. Budenberg, who was in his 78th year, received his early education at Magdeburg, Germany, and later at Manchester Commercial Schools. In 1880, he entered upon a three years' course in engineering at Owens College and graduated, with honours, in engineering, in the B.Sc. degree examination of 1883. In this same year he was awarded the engineering essay prize at Owens College. During his long vacations while at college, he worked in the shops of Messrs. Schaffer and Budenberg, Buckau, Magdeburg, and also in the brass works of Messrs. Robert Harlow, Stockport. In 1883, he was apprenticed with Messrs. Gresham and Craven for two years and subsequently spent some months on the staff of Mr. Lloyd Wise, M.I.Mech.E., patent agent. In 1886 Mr. Budenberg was taken on the staff of the journal *Industries* as sub-editor, but left towards the end of the following year and returned to Germany. During the whole of 1888 he was engaged at the Schaffer and Budenberg works at Buckau and on January 1, 1889, was appointed representative of the firm in England. The firm of Messrs. Budenberg Gauge Company, Limited, was registered in January, 1902, and Mr. Budenberg retained his interest in it until the end. He was admitted as a graduate of the Institution of Mechanical Engineers in 1886 and became a Member in 1894.

MR. F. W. FIRTH.

The death of Mr. Frederick William Firth, which occurred on November 14 at his home, "Redcroft," Ranmoor, Sheffield, removes a well-known figure from the industrialists of the Sheffield area. Mr. Firth, who was chairman of Messrs. The Brightside Foundry and Engineering Company, Limited, Newhall-road, Attercliffe, and Ecclesfield, Sheffield, was in his 65th year. He joined the firm in his early youth, soon after leaving school, and the whole of his active life was spent in its service. After becoming thoroughly acquainted with the business and all its activities, he was made a director of the company and succeeded the late Mr. Thomas Henry Firth, as chairman, soon after the latter's death on July 16, 1925. During the past 16 years the firm has executed some outstanding contracts for rolling-mill plants, illustrated descriptions of several of which have appeared in our columns. Among these were a 35-in. reversing, roughing rolling mill for the Tata Iron and Steel Company, Limited, India; a 25-in. three-high billet rolling mill for Messrs. Andrews Toledo, Limited, Sheffield; and plant for the hot-working of nickel and nickel alloys. The latter comprised a forging press, a three-high universal-type rolling mill, and a three-high Lauth sheet mill. The firm also produced some notable examples of large ingot moulds for the English Steel Corporation, Limited, and other Sheffield firms. Mr. Firth became a member of the Institute of British Foundrymen in 1914, and was a past-President of the Sheffield Branch of the Institute. He became a member of the Iron and Steel Institute in 1918. Mr. Firth was a director of Messrs. Moorwoods, Limited, Sheffield.

COSTING IN RELATION TO PORT OPERATION.*

By Gilbert Wilson.

The need for proper costing methods in port operation, if delays are to be eliminated and charges reduced, is manifest. The standard works on cargo handling and port operation give little more than a passing mention to costing, and there would appear to be room for an authoritative treatise on the subject. The author has, in this paper, only attempted to show the value of a proper costing system and to give a brief outline of such a system. The chief functions of the cost office may be broadly classified thus: (1) To discover the cost of performing any handling operation; (2) to prepare information from which the management may fix a satisfactory scale of charges; (3) to detect inefficiency and waste; and (4) to supply detailed information to the financial accountant. The cost of performing any handling operation will vary with the type of commodity dealt with and the means used to deal with it. The cost per ton of performing each operation should be extracted daily, and weekly and monthly summaries should also be compiled.

Handling costs may be divided into direct and indirect costs. Direct costs are those items which can be attributed wholly and directly to a particular job; for instance, the wages of men actually handling goods. These costs will be ascertained from an examination of the daily time-sheets or time-cards, on which the time-keepers record the wages of each employee and the number of hours he spends at each job. The costing staff and the time-keeping staff must therefore maintain constant close contact in order that any inaccuracies, however minute, may be immediately rectified. Indirect costs are those which have to be allocated over a number of jobs according to some logical rule or system; for example, the working costs of mechanical cargo-handling appliances. The burden of indirect costs is largely, though not entirely, independent of output. A conveyor capable of carrying 150 tons per hour will consume little, if any, less power if its load is reduced, or even if it is running empty. Allocation of power costs on the basis of output is therefore unsound. Generally speaking, "running hours" will prove the most equitable basis for allocating indirect costs. The cost accountant must devote special attention to maintenance costs.

These facts lend weight to the arguments in favour of allocating a periodical fixed sum, based on a predetermined estimate, for maintenance and repairs to machinery. Any difference between this allocation and the actual expenditure can be adjusted in a suspense account, and amended if necessary when the revised or supplementary estimate is rendered later in the financial year. The goods handled by each machine must also bear a charge to cover its depreciation. The most commonly used methods of making this provision are (*a*) the fixed instalment method, under which a fixed percentage of the original value of the asset, based on the estimate of its working life, is set aside annually, and (*b*) the reducing instalment method, under which a fixed percentage of the diminishing annual value is set aside. A sum representing establishment costs must be added to the sum of the direct and indirect costs in order to arrive at the total costs. The allocation of establishment charges is best accomplished, first by a division of the total into departmental sub-totals, and then by a further allocation of these sub-totals over individual jobs.

The greater part of port revenue is derived from dues and charges. Dues are levied on register tonnage and goods entering the port and with them the cost office will have little to do. Charges must cover the cost of performing the service plus a proportion of the establishment costs of the undertaking, and must also include a sum which will be applied to the payment of interest, dividends, contributions to sinking funds and reserves. The fixing of charges is a matter for the management, but they must be based on a firm foundation of cost, and it is the duty of the cost office to supply the management with detailed information of costs for their guidance.

The cost accountant is in a better position than anyone to gauge the relative efficiency of different handling methods and must therefore keep a watchful eye on all such operations from the point of view of cost, and bring to the notice of the management all instances where an expensive or unprofitable method has been used when a cheaper alternative was available. The purpose of the general accounting system is to ascertain the total profit or loss on the undertaking as a whole. The costing system carries the detail of expenditure to a much higher degree of analysis in order to ascertain the cost of any given operation. The two systems, however, are closely interconnected and must be capable of exact reconciliation at any time.

* Abridged from *The Journal of the Institute of Transport*, October, 1941.

TEMPERATURE-INDICATING PAINTS.

An account was given in Engineering, vol. 147, page 517 (1939), of some investigations which had then been recently made by a German firm in exploring temperature differences in the cylinders and pistons of aircraft engines by means of a series of paints which changed colour when exposed to specific temperatures. British paints of this kind have been developed by Messrs. Synthetic and Industrial Finishes, Limited, and are distributed by Messrs. J. M. Steel and Company, Limited, Kern House, 36-38, Kingsway. They have been given the trade name of Thermindex temperature-indicating colours. Obviously, the use of the paints is not confined to the example cited above; their uses can, indeed, be hardly enumerated off-hand. It is possible, however, to visualise the paints being of service on, say, furnace casings, where a change of colour might detect suspected failure of parts of the refractory lining, or they might, in cases where material adjacent was likely to be damaged by excessive heat, show how, if lagging were required, it could be best disposed. In certain chemical processes, too, it is conceivable that a warning of dangerous temperatures might be given should the ordinary thermometric devices fail. Again, in such mechanisms as air-cooled air compressors, the paints might enable the designer to dispose his ducts to the best advantage, and conversely, with electrical and other heating apparatus, how best to utilise the available radiation.

The Thermindex colours take the form of a paint suitable for direct application, by brushing or spraying, to almost any kind of surface, provided that surface is thoroughly freed from grease and loose particles. They can be applied to an already painted surface if that surface is not attacked by the solvent supplied for thinning purposes, a condition which can be readily tested. The solvent, which is also a good medium for cleaning brushes, etc., may be replaced by xylol if desired, but the usual types of paint thinners are not satisfactory. The best results are obtained by shaking or stirring the paint before application, so that the coat is sufficiently opaque to show the original shade. After application the paints dry quickly at normal room temperature. If a hurried test is required, the paints may be heated immediately after application, or, if an immediate determination is not required, they may be left for some time. When the temperature of the treated surface reaches a definite point, the original colour of the pigment changes sharply and the new colour will persist should the surface be cooled down subsequently. A typical selection of the colour changes and the temperatures indicated by them is shown in the accompanying table, in which eight original colours and 23 temperatures are given, the full range comprising 16 original colours and 40 temperatures, the latter ranging from 80 deg. C. to 800 deg. C.

Colour Changes on Application of Heat.

Ref. No.	Original Colour on Cold Surface.	At Deg. C.	Changes to :—
E 102	Pink	115	Blue violet.
		310	Grey.
GG55	Mauve pink	140	Bright Blue.
		315	Grey.
69	Light tan	150	Bronze green.
		240	Deep purple brown.
		310	Pale Indian red.
E 94	Bright violet blue	155	Bright green.
		230	Olive green.
		285	Dark grey.
		290	Light grey.
		300	Light brown.
		340	Buff.
F 41	Ochre yellow	225	Brick red.
E 93	Grey blue	275	Buff.
		290	Creamy white.
E 6	Scarlet	285	Brick red.
		370	Grey brown.
		440	Yellow.
		625	Orange.
E 59	Mauve	400	Fawn.
		515	Grey.
		560	White.

It will be noticed that the different original colours, identified by reference numbers, have not all the same reaction to heat. In the complete range there are a number in which the original colour changes to one other only at the indicated temperature. One such, F.41, is given in the table. On the other hand, other original colours, such as E 94, can be used for a variety of temperatures, as they respond in a different manner to each temperature. This property is valuable in determining localised "hot spots." Thus an area coated with E 94 might show a central buff disc, indicating a region at 340 deg. C., surrounded by concentric rings of the other colours shading off to the original bright violet blue, where, the paint being unaffected, the temperature indicated would be less than 155 deg. C. Although the change of colour is, in the main, dependent on the temperature attained, the length of time to which the colour is exposed to that temperature is also a factor. The standard range of colours have an exposure period of 10 minutes, and the temperatures given in the table are those which produce the colour change within this period; but a colour which indicates a change at, say, 200 deg. C., may, if heated for more than 10 minutes at a few degrees less than 200 deg. C., change at this slightly lower temperature. As, in general, this variation is less than 5 deg. C. it is important, but, where it is necessary to depart considerably from the standard time of exposure, it is not difficult to calibrate the colour to meet these special conditions, this procedure being recommended for accurate work.

All the colours, with a single exception, produce irreversible colour changes, that exception having to be examined while heated. Apart from the standard series of 16 colours, many others can be compounded to cover different temperatures and for special work. The colours have proved to be reasonably resistant to oil vapour and splashes, this characteristic being useful for engine parts coming into occasional contact with lubricating oils. A measure of protection can be given by a fixative solution obtainable with the colours, but we understand that special types are being developed for use where resistance to attack by oil is of primary importance.

NOTES FROM SOUTH AMERICA.

There is a distinct return of optimism in the South American outlook, particularly because of the arrangements being made by the United States Government, under their rearmament plan, to purchase the bulk of the metals and other strategic war materials produced south of the Rio Grande. Conversely, because of shortage of shipping and essential supplies from Europe, there has been a swing-round in South American import markets. They are now feeling the scarcity of essential imports, especially fuel, metals, engineering equipment, etc.; broadly speaking, South America's purchases from the United States and the United Kingdom—practically the only remaining sources of supply—now depend upon what these two countries are able to export, rather than upon what South America is able to buy. In consequence, there is a distinct tendency in South America towards relaxation of exchange and import restrictions, and the countries appear willing and able to pay for any British goods that the Board of Trade may allow to be shipped under the present permit system.

The short supply of foreign goods is illustrated by the fact that Argentine imports of iron, steel and manufactures, during the first nine months of 1941, fell in value to 44,418,000 pesos (against 85,793,000 pesos in the like period of 1940); other metals and manufactures, 41,002,000 pesos (54,279,000); machinery and vehicles, 41,805,000 pesos (90,265,000); and timber and manufactures, 31,781,000 pesos (31,390,000). The relaxation of import restrictions is particularly noticeable in Argentina, where there is an increasing shortage of essential goods required for manufacturing industries, public utility companies, etc., and including metal and manufactures, tinplate, automobiles, etc.

The shortage of fuel and freight space is a pressing war-time problem in South America, but the United States authorities have expressed the intention to make every possible effort to assist in fulfilling the petroleum requirements of the Southern Republics, and the newly-formed Petroleum Supply Committee for Latin America has been authorised to facilitate equitable distribution of petroleum products throughout South America and to ensure the best possible use of available tanker tonnage. The consumption of fuel in Argentina is being strictly rationed, and similar steps are being taken in other republics. Argentina has purchased Italian and Danish ships formerly held up in Buenos Aires.

Under present threats from the Axis, the United States is pursuing a policy of close co-operation with the Latin-American republics in both the economic and political spheres. Mutual trade agreements have recently been signed and, in addition to trading credits granted by the Export-Import Bank of Washington for the export of railway, engineering and other capital goods to South America, additional facilities are now being given under the Lease-Lend Act for the defence of South America. Thus, the United States is making a loan in Brazil of 90,000,000 dols. under the Lease-Lend Act, the proceeds to be applied mainly in the construction of naval and air bases on the North Brazilian coast, the extension of naval ship-building yards at Rio de Janeiro, and the expansion of the Brazilian navy. Repayment of the loan will be effected by supplying the United States with strategic materials, such as minerals and copper.

The United States is also lending 11,000,000 dols. to Paraguay and 17,000,000 dols. to Uruguay under the Lease-Lend Act for defence purposes. Constructional work on the important Rio Negro hydro-electrification scheme in Uruguay is expected to be finished in December, 1941, but thereafter work on the scheme will probably be suspended until after the war, unless it is found possible—which is unlikely—to obtain certain machinery in the United States. It may be recalled that the contract for this power scheme, which is intended to supply electricity throughout Uruguay, was placed in Germany and work was commenced in 1937. The contructional work has since continued without interruption, but the transport of the necessary operating machinery from Germany has not been possible owing to the war. Expropriation of certain lands in the valley of the Rio Negro has been decreed, and will probably take place immediately, although, in view of war-time difficulties, the date for flooding the land has been postponed until 1943.

The export trade of Brazil is buoyant, so that the exchange market continues normal and liquid. The establishment of the new National Steel plant near Rio de Janeiro proceeds apace. The company is also buying from the United States a complete installation for the production of coke, ammonia, tar, benzol and toluol. A loan of 1,220,000 dols. is being obtained from the Export-Import Bank of Washington for the purpose of financing the installation of a motor factory in Brazil. Brazil's production of pig-iron in the first six months of 1941, nearly 92,000 tons, was almost equal to the annual production some four years ago. The steady development of hydro-electric resources, coupled with the increase in the industrial and domestic consumption of electricity, continues to make Brazil an important market for all kinds of electrical material. Under the Five-Year Development Plan commenced in 1939, the expenditure on transport and public works in 1940 was 130,000 contos (over 1,500,000*l.* sterling). A recent decree authorises the Central of Brazil Railway to contract with American manufacturers for the supply of central signal equipment to the value of 1,571,000 dols., payment to be spread over a period of seven years. During the first eight months of 1941, Brazil's imports of engineering and allied items were as follows, the comparable figures for the like period of 1940 being given in parentheses :—iron and steel manufactures, 351,209 contos (490,437); motor-cars, lorries, chassis, etc., 155,440 contos (138,468); accessories for motor-vehicles, 137,945 contos (121,751); tyres, 17,600 contos (32,091); other transport material, 74,504 contos (145,130); generators, motors and other electrical machinery, 147,535 contos (95,468); other machinery, tools, etc., 469,423 contos (445,236); petrol, fuel-oils and lubricants, 306,823 contos (370,688); coal, coke and patent fuel, 156,320 contos (198,476); non-ferrous base metals, 73,547 contos (80,187); scientific instruments, 46,684 contos (33,757); radio apparatus and accessories, 44,893 contos (35,995). Many engineering projects, both private and public, are being pursued in Brazil, particularly to develop national industries and communications; for example, the electrification of railways. The municipal authorities of Rio de Janeiro recently opened a credit of about 8,000,000*l.* sterling with the Bank of Brazil to finance new public works in that city.

Chile is benefiting by North American purchases of copper and other strategic materials, and also nitrate. Exchange stringency in sterling has disappeared and Chile is prepared to pay for all goods that Britain can ship under Board of Trade licence. Local manufacturing industries are expanding, assisted by the Government, with an implied demand for engineering equipment, etc. During the first six months of 1941—the latest period for which figures are available—Chile's imports of various items were as follows, the comparable figures for the same period in 1940 being given in parentheses :—machinery, tools, electrical material, etc., 29,502,900 pesos of 6*d.* gold (23,511,500); iron, steel and other metals and manufactures, 25,112,600 pesos (31,007,200); transport material, 20,488,800 pesos (18,284,600); crude petroleum and Diesel oil, 18,909,900 pesos (16,284,700); scientific instruments, etc., 7,253,500 pesos (6,609,300). Among other developments in Chile, it is proposed to construct a hydro-electric plant in the province of Valdivia, utilising the falls of the Huilo-Huilo, the cost being estimated at 200 million pesos.

The United States is also negotiating to purchase Peru's production of copper, lead and vanadium. Peruvian trade is at a high level, and the exchange market continues untrammelled, with much improvement in the sterling situation, due mainly to British Government purchases of cotton. So far, no Government assistance has been required to deal with difficulties arising from the present international situation. The national manufacturing industries are forging ahead, and large-scale schemes are in hand for developing the iron and steel industry, adumbrating a considerable demand for the necessary machinery and equipment.

MOBILE WORKSHOP FOR THE L.M.S. RAILWAY.

MOBILE WORKSHOP FOR THE LONDON MIDLAND AND SCOTTISH RAILWAY COMPANY.

The accompanying illustration shows a useful mobile workshop developed by the Road Motor Department of the London Midland and Scottish Railway Company. It is well known that this company maintains a large fleet of motor and other vehicles distributed widely over its extensive system, the repair and maintenance of these vehicles being carried out in permanent workshops at various places. Since it was within the bounds of possibility that individual workshops might suffer damage from enemy action, the railway company decided to provide mobile workshops which could be taken to any place to provide repair and maintenance facilities. Apart from this, there is a field of useful service for the mobile unit in areas remote from road-motor workshops for the maintenance of motor vehicles and other railway equipment. The mobile workshop does not travel under its own power, but is arranged for towing by any suitable vehicle.

An important part of the equipment, not visible in the illustration, is a generating set for power and lighting which is installed on the floor of the workshop at the drawbar end, the switchboard being attached to the wall at the left-hand of the figure. The set consists of a Lister water-cooled petrol engine developing 7 h.p. at 1,500 r.p.m. and driving a 2¼-kW generator supplying direct current for light and power at 110 volts, and a 500-watt generator supplying direct current at 6 volts or 12 volts for battery charging. The charging operation is not carried out inside the workshop on account of the fumes arising from it, but the batteries are stowed, while being charged, in a cupboard-like recess below the chassis frame and immediately behind the drawbar frame. Incidentally, it will be noticed that this frame is formed so that the drawbar can be attached at any one of four different levels so as to give a horizontal pull with all the types of towing vehicles likely to be used. The lettering seen immediately above the frame indicates the position of the charging connections, of which there are four for 12-volt current and one for 6-volt current. The 110-volt current is used for lighting while a battery supplies current for a light in the workshop when the engine is not running. The generating set also provides current for driving electric tools, such as grinding machines, valve-refacing equipment, drills, etc. A two-wheel grinder can be seen on the right of the bench. Small tools, such as taps and dies, and spare parts, are accommodated in drawers under the bench or in the racks behind it.

Apart from the generating set and the electrically-operated machine tools above referred to, the workshop is equipped with certain auxiliaries. Some of these can be seen in the illustration. On the left is a portable oxy-acetylene cutting and welding set made by Messrs. Gordon Equipments, Limited, 25, Milton-street, London, E.C.2, and near it is a blacksmith's forge. On the right-hand side of the figure is a self-contained portable tyre-inflating set, supplied by Messrs. J. A. Prestwich and Company, Limited, Northumberland Park, London, N.17. This set consists of a petrol engine driving a rotary compressor, running at 600 r.p.m. and capable of delivering from 8 cub. ft. to 9 cub. ft. of free air per minute at a pressure of 120 lb. per square inch. The normal pressure of the vehicle tyres is of the order of 100 lb. per square inch. These auxiliaries are stowed in the workshop during transit, as also are the tyre-removing equipment and the platform ladders. The portable tank seen in the centre of the illustration, on the other hand, is carried in a cage suspended from the underside of the chassis frame between the wheels. The tank is mounted on a pair of wheels and a swivelling castor, and is easily run in and out of the carrying cage. It is fitted with a pedal-operated semi-rotary pump so that clean oil can be conveyed in it and pumped into an engine sump; or dirty oil can be removed from a sump. It may also be used for cleaning parts in paraffin, etc. Clean oil and dirty oil, respectively, are stored in a pair of tanks under the chassis at the trailing end of the vehicle, the dirty oil being saved for re-conditioning by the recovery plant at certain of the depots. In line with the tank cage under the chassis is a metal bin for holding metal scrap.

When travelling, the workshop is entirely closed. The lower half of one side constitutes a platform, and the upper half forms an awning, folding inwards. The entrance door is in the trailing end. The step ladder to this door and those at each end of the platform are constructed so that their height can be reduced, as will be clear from the ladder on the left hand of the illustration. The reason for this construction is that, when the workshop is likely to stay in one place for some time, the wheels are removed and the vehicle is supported on chocks, which are carried as part of the equipment. The top of the vehicle is made with a parapet providing a space for accommodating tyres, timber for body repairs, etc., and also for a large tarpaulin which can be extended over the vehicle undergoing overhaul.

The overall dimensions of the workshop are 16 ft. 8 in. long by 7 ft. 4 in. wide by 12 ft. 1 in. high and the tare weight is 4 tons 5 cwt. It is carried on four pneumatic-tyred wheels with a swivelling fore-carriage. The brakes are of the vacuum-assisted type, actuated from the towing vehicle. The workshop can be safely towed at a higher speed than the 20 m.p.h. which is the statutory speed for vehicles of its weight. The mudguards are of rubber. This practice has been adopted by the railway company on motor vehicles for some time and is now standard. The workshop was constructed at the company's works at Wolverton and we understand that, after the completion of tests in service, it is intended to construct further units.

Locomotives for Rocky Mountains Lines.—The Union Pacific Railway recently placed in operation, on its Rocky Mountains lines, what is described as the largest locomotive in the United States. It weighs 596 tons, with tender, has a length of 133 ft., and can develop 7,000 h.p. It is designed for a maximum speed of 100 miles per hour and a sustained speed of 70 miles per hour. We are informed that, in all, 20 of these locomotives are to be built for service on this railway.

THE TREATMENT OF TIMBER IN A DRYING-KILN.*

The three essential factors concerned in the drying of wood through the medium of the surrounding air are the movement, temperature, and humidity of the air. The effects of air temperature and humidity on the drying of timber are generally well understood; but the equal importance of air movement in the drying of a commercial-sized load of timber seldom receives the attention it deserves. Air movement is necessary, because in whatever way the general condition of the surrounding air is controlled, heat must always be conveyed to, and moisture removed from, the surfaces of every board, if drying is to continue. Air movement in kilns is generally produced either by convection in what are termed natural-draught kilns, or by forced draught in kilns in which fans are incorporated in the design.† The natural-draught kilns are capable only of producing an air movement that is comparatively slow and easily affected by external conditions, etc.; the air movement in fan kilns is usually much faster and much less affected by extraneous circumstances. In both types it is usual to arrange for the air to circulate continuously at the maximum possible speed consistent with the general design, and to maintain this speed at a more or less constant value throughout the drying process.

Kiln-Drying Routine.—To control the drying of a load of timber according to a prescribed schedule of operations, it is essential that the operator should be able to ascertain the moisture content of the load as a whole at any time and to examine the general condition and behaviour of the timber without actually dismantling or disturbing the pile. Sample boards should always be selected at random from the load at the start of the run, tested for moisture and inserted into various parts of the pile. The methods of testing the moisture content and of placing the necessary samples are described in *Forest Products Research Leaflet No.* 7, "Moisture Content Determination by the Oven-drying Method." When once the moisture content is known the operator can, from his own experience or that of others, decide upon the air temperature and humidity which are most suitable for wood in that particular state. Wood, however, even of one species, is extremely variable in character and an operator should never bind himself rigidly to any predetermined schedule, but should weigh and examine the sample boards and inspect the load as a whole at fairly frequent intervals and should be prepared at any time to adjust or alter the drying conditions to conform to the observed condition of the timber.

Operation of a Kiln.—The operator must be able to determine and control the conditions of the air as it enters the pile and instruments have been manufactured for use in a kiln which will record these conditions, some automatically controlling them within fine limits. Recording instruments provide useful records of each run and a check on the behaviour of the kiln, but they are more of a refinement than an absolute necessity. A very efficient instrument is the simple wet and dry bulb hygrometer, consisting essentially of two ordinary mercury-in-glass thermometers, one bulb of which is kept wet by a wick. One end of the wick is attached to the mercury bulb of the so-called wet-bulb thermometer, and its other end dips into a glass bottle or flask which can be filled with distilled water through a conveniently fixed copper tube leading to the outside of the kiln. The thermometers should have a clearly defined graduated scale which, if suitably illuminated, can be read from outside the kiln with the aid of a pair of field glasses. When fixing these hygrometers at different points along the main inlet and outlet passages, care should be taken to see that the bulbs are directly in the path of the main air flow and are not shielded or baffled in any way, so that they indicate the true conditions of the air entering and leaving the pile. The nearest bulb should be at least 6 in. from the wall of the kiln and far enough from any opening to be unaffected by cold air from the outside.

The cooling of the wet bulb below that of the dry is due to the evaporation of moisture from the moist cover with which it is surrounded. The lower the humidity of the air, the greater the evaporation and the greater the lowering of the wet-bulb temperature, and by means of tables or charts the relative humidity can be found, if the dry and wet bulb temperatures are known. The actual manipulation of a kiln to give the necessary dry and wet bulb readings is simple after a little practice. The control is confined to the adjustment of heating coil and spray valves, together with the occasional adjustment of air inlet and outlet dampers.

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* *Leaflet No.* 20. Abridged. Issued by the Forest Products Research Laboratory, Department of Scientific and Industrial Research. Crown copyright reserved.

† See ENGINEERING, page 201, *ante*, "Timber Drying Kilns: The Overhead Internal-Fan Kiln." Forest Products Research Laboratory.

The dry-bulb temperature may be controlled by regulating the amount and pressure of the steam entering the heating coils and the number of banks of coils put into operation. The wet bulb readings, and hence the humidity, may likewise be raised or lowered at any time by increasing or decreasing the amount of live steam permitted to enter the circulating air through the steam spray. A further control is secured by opening the air vents when a reduction in humidity is required and closing them if the humidity is to be increased. For economical working, only very slightly more moisture should be allowed to escape from the kiln by means of the exhaust vents or chimneys than is being extracted from the timber at any given time, and this slight deficit should be made good by introducing a comparatively small amount of steam into the circulating air by means of the steam spray.

Application of a Drying Schedule.—In practice it is usual to adopt a drying schedule evolved from previous experiments in drying the same, or kindred, species. Lists of drying schedules found by experience to be most suitable for a large number of timbers used in commerce may be obtained on application to the Forestry Products Research Laboratory. Dry and wet bulb temperature readings appropriate for the proper drying of wood at various moisture content values are given. Since the humidity of the air, so important a factor in the control of the drying, is determined by the difference between the two temperature readings, it is far more important for the operator to maintain the correct difference than to maintain the exact temperatures given in the schedule. Although, theoretically, each kiln thermometer should be calibrated against a standard, it will generally be sufficient to take the pairs of thermometers and immerse them in a bucket of water heated to a temperature of, say, 140 deg. F. (60 deg. C.). When the readings of the two are steady, the difference, if any, should be noted and this inherent difference should then be allowed for in all subsequent kiln temperature adjustments as recorded by the hygrometer in which the two thermometers are incorporated.

Experience with the schedules listed will generally point the way to modification to suit particular requirements and timber of any particular quality. Strictly speaking, a drying schedule for any one species should vary not only according to the quality of the wood, but also according to the thickness of the material and the air speed over the surfaces. Thus, good quality material will tolerate more severe drying conditions than poor quality material and quarter-sawn boards will generally dry slower but with less degrade than slash-sawn boards of the same species. It is always, then, most desirable when dealing with a mixed load to include samples taken both from quarter-sawn and poor quality material so that these test pieces may be truly representative of the load as a whole. The schedules listed are designed primarily for use with timber up to about 1½ in. thick of random-sawn material and are based on the assumption that forced air circulation is available. With a slow circulation of air as is usual in natural draught kilns, the humidities employed may be at least 5 per cent. or even 10 per cent. lower at each stage. These lowered humidities will compensate, in part, for the slower air movement, and the drying rates in the two types of kiln will hence differ to a rather lesser degree.

Reversal of the Air Circulation.—Timber situated near the side where the air enters the pile dries faster than timber near the side where the air leaves, while the drying rate of the latter may lag appreciably behind the former. One side of the pile may then become dried to the desired moisture content figure, while the other side is still wet. In such cases it is advisable to reverse the direction of air flow so that the drier air enters the wetter side of the pile. If reversible circulation is employed, means of measuring the air conditions on both sides of the timber pile and of controlling the kiln on whichever hygrometer happens to be on the air-inlet side, should be provided. Each hygrometer installed in a kiln should be placed so that the bulbs are directly exposed to the main flow of air and are, say, 2 ft. to 3 ft. above the floor, and at least 3 ft., preferably more, from the end of the pile.

(To be continued.)

Transfer Deeds for Paper Salvage.—The Board of Trade draws the special attention of company directors and secretaries to the provisions of a new Defence Regulation (S.R. & O., 1941, No. 1778). The effect of this Regulation is to protect a company from any liability in respect of the destruction of transfer deeds of its securities at any time not earlier than three years after the transfers had effect. The Regulation applies to documents transferring the company's shares, stock, bonds, debentures and debenture stock. In view of the paper shortage the Board of Trade hopes that directors will take full advantage of the protection afforded by this Regulation and make available, as waste paper, the accumulation of transfer deeds which it has frequently been the practice to retain for long periods.

LABOUR NOTES.

The writer of the editorial notes in the November issue of the Amalgamated Engineering Union's *Journal* says that "the Trade Union Movement knows nothing of a National Shop Stewards' Movement." "It gives its official recognition," he continues, "to no such body as a National Shop Stewards' Council. It lends no countenance to conferences of shop stewards called by any such outside body for any purpose whatsoever, and, so far as the Amalgamated Engineering Union is concerned, our accredited shop stewards have been informed officially that if they attend such conferences they do so entirely on their personal responsibility and in a non-official capacity. Their presence at such conferences or attachment to the Shop Stewards' Movement (so-called) in no way commits this Union or implies this Union's approval of the decisions or views embodied in their resolutions or speeches."

The contributor of the notes appeals to the organisation's shop stewards "to act responsibly in their official positions and with a full sense of their duty to the Union, to the workers who choose them, and to the industry." "We appeal to them," he writes, "to consider the potential difficulties arising out of their association with an unofficial organisation claiming to represent shop stewards independently of the unions whose credentials they hold. We remind them that the Union is responsible for their actions in so far as they exercise their functions in the workshops under agreement with the employers. And we ask them to remember that when they act independently of the Union at the instigation of an irresponsible person or council—irresponsible, we mean, in the sense of not being answerable to any constituted authority as union officers and executives are—they are laying up a store of trouble for the whole Trade Union Movement."

"We will say nothing," the writer proceeds, "about the propaganda to which some shop stewards have lent their support, except this: Are those who are agitating for a western front to relieve the pressure on Soviet Russia quite sure that this is what the Soviet authorities want? Is it consistent on their part to agitate for the dispatch of a new expeditionary force to open up a 'second front,' which must take all the munitions we can produce and infinitely more than we have the present capacity to produce, whilst they demand in the same breath that we shall send everything we can produce in the way of tanks and aeroplanes and other munitions of war to Soviet Russia? This sort of propaganda seems to us to be self-contradictory."

In his account of the conference with the Engineering and Allied Employers' National Federation on the claim for an increase of wages, Mr. Tanner says that one of the points made by Sir Alexander Ramsay in intimating that the employers could not see their way to agree to the proposal, was that "it would be bad statesmanship if they took steps at the present to build up standards which we would be unable to maintain when we returned to normal life and trade." After considering the employers' reply, the executive council decided to refer the claim to the National Committee in compliance with the resolution adopted by that body at its meeting in June. The recalled meeting of the National Committee was held at Leicester on Tuesday this week. At the time of writing no official news of its decision is available, but it is expected that the claim will be referred to the National Arbitration Tribunal.

The Ministry of Labour and National Service states that on October 13 there were about 216,000 employees on the registers—185,850 wholly unemployed, 20,450 temporarily stopped, and 9,900 normally in casual work. Wholly unemployed men and boys numbered 97,034—a decrease of 3,014 in a month; temporarily stopped, 6,620—a decrease of 1,304; and casual workers, 9,420—a decrease of 91. For women and girls the figures were:—Wholly unemployed, 88,816—a decrease of about 7,700; temporarily stopped, 13,832; and casual workers, 477. Of those wholly unemployed about 3,400 were unsuitable for normal full-time work, and 4,000 were unable for good cause to transfer to another area.

According to the report of the General Federation of Trade Unions for the third quarter of the current year, there are now 90 affiliated societies, 54 on the higher scale, 34 on the lower scale, and two on both scales. There are 151,320 members on the high scale, 102,133 on the lower scale, and 5,967 on both scales. The membership on which contributions are based is 259,420, and the gross membership of the affiliated societies 308,694. During the three months ended September 30, the contributions received amounted to 5,114*l.* 13*s.* 9*d.*, and the benefits paid out to 13*l.* The assets of the Federation have a value of 338,921*l.* 19*s.* 4*d.* This, Mr. George Bell, the general secretary, says, is the highest total in the history of the organisation.

In the course of an examination of the problems which will have to be faced when the war comes to an end, Mr. Bell says that the economic position of many, if not all, of the world's basic industries "has been built up on low production costs and cheap transport." "This has been fought by organised labour," he claims, "and made more humane. There is always, however, the inevitable effects of severe competition between the backward countries and the countries which have striven to establish a higher social order for their workers. To enable the workers of the world to live and labour decently and healthily, a change of heart and mind is necessary in those who control international finance and in those who employ in all countries. The old way is an easy way of life for some, but it is death for many and it must be altered."

In October, the home-branch membership of the Amalgamated Engineering Union increased from 518,273 to 532,568 and the Colonial-branch membership from 50,709 to 52,172. The number of members in receipt of sick benefit increased from 4,620 to 4,915 and the number of superannuated members decreased from 13,311 to 13,300. The number in receipt of donation benefit decreased from 188 to 151 and the total number of unemployed members from 1,350 to 1,231.

The twenty-first report of the Select Committee on National Expenditure—which was ordered to be printed in August last—contained a number of recommendations on the subject of the output of labour. The Government have considered these recommendations, and their comments on them are given in a White Paper which was issued on Wednesday last week. Investigations, it is stated, have proved that, over an extended period, weekly hours of work should not exceed 60 for men and 55 for women. It appeared to be more useful to take all possible steps to restrict weekly hours within these limits than to have further investigations made which were unlikely to produce different results. The Select Committee had recommended that the Industrial Health Research Board should carry out investigations to determine the best length of working week.

Another recommendation of the Select Committee was that workpeople should have one day's rest in seven. On this point, the Government comment is that a system under which production goes on every day and the workers get various days off in the week in rotation might well be extended at a number of factories, but that it would seem that in very many, if not most, cases, five and a half or six days of production—with or without two day shifts or day and night shifts—was the better arrangement. All Departments, it is added, agree that Sunday work—except at the beginning or end of night shifts or where the workers get a break of at least 24 hours under a rota or relief system—should be restricted to essential maintenance or repair work and to meet exceptional emergencies.

The *Daily Herald* states that, at a conference in Leeds, the executives of the unions in the National Federation of Building Trades Operatives agreed to play their part in guiding policy on the application to the industry of payment by results. This does not mean, it is explained, that the unions have abandoned their opposition to piecework, but merely that they are prepared to take part in controlling it for the duration of the war. Bonus is to be payable for work done over a fixed hourly output and it is to be calculated for gangs and not for individuals.

Broadcasting on Friday last week, Sir Walter Citrine said that, in the two factories which the Trades Union delegation to Moscow visited, men and women are working 11 hours a day with one day off in seven for rest. Practically everyone is on piecework, and some workers have increased their output above the basic amount by between 230 and 463 per cent. "We found," Sir Walter added, "that these record-breaking results were obtained more by the workmen's ingenuity in finding simple ways of doing the jobs than by hustling themselves to pieces."

Royal Gold Medal for Architecture.—On the recommendation of the Royal Institute of British Architects, H.M. The King has signified his approval of the award of the Royal Gold Medal for Architecture, for 1942, to Mr. William Curtis Green, R.A., F.R.I.B.A.

COUPLED RAILCARS FOR THE G.W.R.

MESSRS. THE ASSOCIATED EQUIPMENT COMPANY, LIMITED, SOUTHALL.

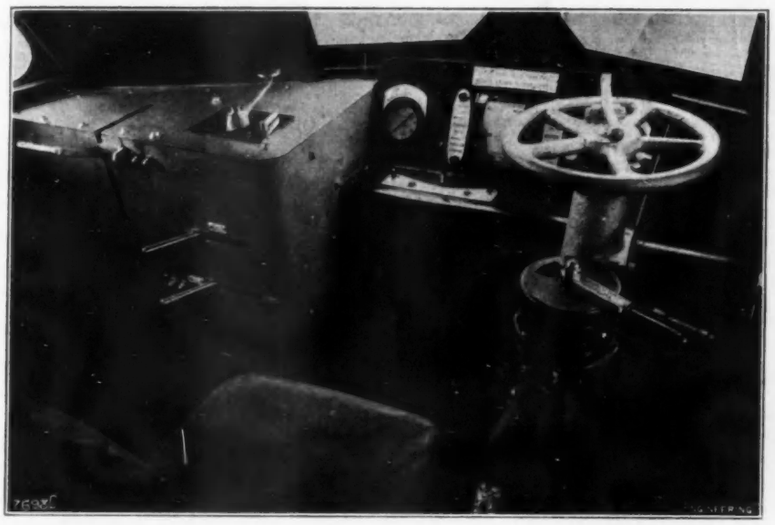


FIG. 3. DRIVER'S CAB.

FIG. 4. INTERIOR OF BUFFET CAR.

COUPLED RAILCARS FOR THE GREAT WESTERN RAILWAY.

ONE of the pioneers of the steam railcar, the Great Western Railway Company, still continues development and experiment in this self-propelled type of railway coach, the latest example being illustrated in Figs. 1 to 4, on page 410 and on this page. The machinery and running gear of the new stock has been constructed by Messrs. The Associated Equipment Company, Limited, Southall, Middlesex, the coach bodies having been built and finished at the Swindon works of the Great Western Railway Company. The photograph reproduced in Fig. 1, on page 410, shows the twin-coupled railcar unit, both of the coaches forming the unit having identical driving mechanism and a driving compartment at one end. A normal connecting gangway gives access from one coach to the other. Apart from the drive and the fact that each has a central entrance door, the vehicles are, however, differently laid out. In the car to the right, No. 35, seating accommodation, for 28 passengers and for 32 passengers respectively, is provided in the compartments flanking the entrance vestibule. There is a luggage compartment behind the driver's cab and, at the gangway end, a lavatory and a small compartment containing an oil-fired boiler for steam heating. The car to the left, No. 36, has also a compartment on each side of the vestibule, that at the front seating 32 passengers and that at the rear seating 12 passengers and containing a buffet counter.

The coupled unit as shown in Fig. 1, thus accommodates 104 passengers but, in order that the accommodation may be increased if necessary, the cars are designed so that a standard 10-compartment coach may be inserted between them. This arrangement is illustrated in Fig. 2, page 410, in which view the car on the right is No. 35. The total seating accommodation provided by the two cars and the coach is sufficient for 184 passengers and there is through communication between the three vehicles. The engines of both railcars are run together normally, the necessary electrical connections between the two being carried along the underframe of the intermediate corridor coach. The two car sets have been designed primarily for working over the 117-mile route between Birmingham, Gloucester, Newport and Cardiff. Single railcars, also constructed by Messrs. The Associated Equipment Company, were put into this service in 1934, and were described and illustrated in ENGINEERING, vol. 139, page 46 (1935). These cars, which were the first oil-engined railcars to be equipped with a buffet and lavatory, held only 44 passengers, and so popularised the route, largely on account of their faster timing, that they became inadequate to handle the growing traffic and had to be replaced eventually by steam trains. The increased accommodation of the coupled units, and of the three-unit trains, may meet the demand and enable oil-engined vehicles to be again employed.

The railcars each measure 62 ft. over the headstocks and are mounted on two four-wheel bogies at 43 ft. 6 in. centres, the bogie wheelbase being 8 ft. 6 in. The two-unit set has a tare weight of 72 tons which is increased to 108 tons when the 10-compartment corridor coach is added. The gross weight of the three-unit set when loaded with passengers and luggage is approximately 120 tons. Each railcar is driven by two A.E.C. six-cylinder direct-injection oil engines, as were the 44 seat railcars mentioned above. In this case, however, the cylinder bore has been increased from 115 mm. (4·52 in.) to 120 mm. (4·72 in.), the stroke of 142 mm. (5·59 in.) remaining the same as before. Each engine develops 105 b.h.p. at 1,650 r.p.m. The engines are carried on the chassis, so that the body space is not encroached upon nor disturbed for examination and overhaul of the mechanism. Overhaul, moreover, does not involve disturbance of the bogies or removal of the wheels from the axles. The position of the engines is indicated in Figs. 1 and 2 by the "dropped" housing below the body sides. The engines are fitted with an oil-cooling system using water-cooled grids in the main sump.

All four axles of the railcar are driven, each of the two engines driving the wheels of one bogie. Transmission from engine to axle is through a fluid-flywheel, a five-speed epicyclic gearbox, and a bevel-type final drive, with reverse, in the inner axlebox of the bogie. The outer axle is also bevel-driven and is coupled to the inner axle by the Cardan shaft clearly visible in Fig. 2. The gearbox provides speeds of 12, 17, 30, 46 and 75 miles per hour. The maximum tractive effort in bottom gear is 11,380 lb. and in top gear is 1,840 lb. Among the improvements over the railcar described in the above-mentioned previous article are the re-designing of the axleboxes for S.K.F. roller bearings and the adoption of two-tread brake shoes on each wheel, instead of the former internal expanding shoes and drum on one wheel of each axle, the brakes being vacuum-operated. The control system is electro-pneumatic, and is designed to give definite control of all motive power equipment under the driver's direction, irrespective of the air pressure available.

The interior view of the cab given in Fig. 3 shows the convenient grouping of the various controls relative to the driver's seat, the instruments being arranged on a dashboard. By the use of an ingenious pre-selector motor, five speed gear-positions are obtained with only three magnet valves, a similar device being used to obtain equal throttle openings on all four engines. Single-lever shunting controls, which can be easily operated by the driver while leaning out of the window, are provided. There are the usual auxiliaries, such as sander, horn, etc.

The body is noteworthy from the adoption of flat surfaces and straight lines wherever possible instead of the curves of earlier cars; for example, the old elliptical roof contour has given place to one made up of four flat surfaces, a construction perhaps most evident in Fig. 1. The same semi-octagonal contour has been adopted for the cab front. These changes have resulted in the addition of another 12 in. in body space longitudinally, while a further 6 in. have been gained by carrying the body over the headstocks at the rear of the car. An interior view of car No. 36, looking towards the cab, is given in Fig. 4, the door at the end being that opening into the luggage compartment. The buffet counter is seen on the right and the entrance vestibule in the middle distance. The buffet equipment includes a small gas stove for the preparation of light hot meals, which can be served at the tables fitted between all the seats in both cars, except the four facing the buffet. There is ample cupboard provision on the serving side of the counter and a refrigerator cupboard in the gangway corner. For decoration the prevailing colour is green, of various shades and is employed in the patterned moquette of the seat upholstery, the lower lining panels of Rexine, the central carpet strips and linoleum and the silk-finished curtains on the car and vestibule windows. These curtains, when fully drawn, enable full lighting to be maintained during blackout hours, there being eight roof-light clusters in each car. The windows are large and are fitted with sliding metal-framed ventilators of the latest G.W.R. pattern.

A test run of the twin railcar with a standard corridor coach coupled between the two parts, as in Fig. 2, was made, on October 15, from Southall to Westbury and back, a total distance of 172·5 miles. The tare weight of the complete train was 108 tons, and with passengers was approximately 110 tons. The addition of the corridor coach reduced the horse-

power available per ton by approximately 30 per cent. and had some effect on the speeds obtained, especially when accelerating or on gradients. In spite of this, speeds of 70·5 m.p.h. were officially observed on the return journey at Bedwyn and Newbury. It may be noted that even at this high speed both the railcar and the corridor coach gave remarkably smooth riding, as was, in fact, the case at all speeds. The line traversed is practically level from Southall to Newbury, rising gently after the latter station is passed to Bedwyn, after which the gradients become steeper to Savernake summit. Descending gradients follow to Pewsey, and thence the line undulates to Patney, thereafter dropping fairly steeply to Lavington. There were signal checks on both the outward and return trips, the average speed for both trips working out at 45 m.p.h. The fuel consumption for the day was 49 gallons, which gives 3·6 miles, or 396 ton-miles, per gallon.

SILVER IN ENGINEERING.

HITHERTO the use of silver in engineering practice has been mainly in the form of silver-solder. Of late, however, considerable research has been undertaken with a view to extending the field of usefulness of this metal. Such a research is being carried out under the auspices of the American Silver Producers' Research Project at the laboratories of Messrs. Handy and Harman, Bridgeport, U.S.A., to which plant the work was transferred from the United States Bureau of Standards, at Washington, in June, 1940. One of the most recent activities has been to examine the possibilities of silver as a substitute for aluminium, nickel and tin. In cases where sheet or foil aluminium has been employed, either for high reflectivity or for resistance to corrosion, it is stated that silver plating on various metals can be substituted, it being claimed that the coating possesses these characteristics to a higher degree than does aluminium. Electro-deposited silver is also being investigated for use instead of nickel as an undercoating for chromium plating, and experiments are being made to determine whether any advantages will result from the use of a corrosion-resisting electro-deposit of silver under a hard wear-resisting chromium deposit.

Pure-tin tubing has hitherto been employed in certain apparatus, such as that using distilled water, and tin-silver alloys have been investigated for such applications. In a bursting test, extruded tubing made from an alloy of 3·5 per cent. of silver and 96·5 per cent. of tin showed a strength almost double that of pure tin tubing, and threaded joints had a tensile strength 25 per cent. greater than joints made with pure tin tubing. Perhaps the most important investigation is that concerned with the use of lead-silver solders in automatic can-making machines. The standard solder employed in these machines consists of equal parts of lead and tin, but a solder consisting of 2·5 per cent. of silver and 97·5 per cent. of lead is claimed to give equally satisfactory joints and to be cheaper than the lead-tin solder. It is stated that many of the larger manufacturers of cans are experimenting with alloys of this kind to obtain data on actual operating conditions and service tests. In connection with can manufacture it has been found that for certain corrosive materials the usual tinning or internal lacquering is not satisfactory, and tests of silver-lined containers are being carried out. The 3·5 per cent. and the 5 per cent. tin-silver alloys are also finding application as solders, and investigations are being made of silver brazing alloys for use in silver-to-silver joints such as are employed in silver-lined chemical equipment.

MACHINE-TOOL MANUFACTURE IN THE UNITED STATES.—The American National Machine-Tool Builders' Association has reported that the output of machine tools in the United States was valued at 64,300,000 dols. in August, this figure constituting the highest total in the history of the industry. The total value of the July output was 57,900,000 dols. and that of the June output, 63,000,000 dols. In August, 1940, the total value of the production was estimated to be 40,800,000 dols.

LUBRICATED EXPANSION REAMER.—Where long holes are to be reamed, the performance of the expansion reamer made by Messrs. A. C. Wickman, Limited, Coventry, has been found to be improved by the introduction of a lubricant at the Wimet-tipped cutting edges. The shank of the reamer, which was described in ENGINEERING, Vol. 147, page 184 (1939), is drilled axially and the outer end is plugged. A connection is provided on the shank to receive a flexible oil-supply pipe. The grooves in the reamer distribute the oil flow to the cutting edges. We understand that this simple arrangement has proved very successful in practice.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

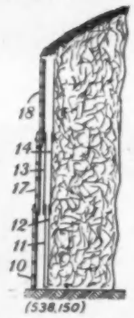
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AGRICULTURAL APPLIANCES.

538,150. Silo. J. H. Sankey and Son, Limited, of London, British Sisalkraft, Limited, of London, and C. A. Z. Ward, of London. (2 *Figs.*) April 30, 1940.—The silo is of the portable wire-walled type and is designed to minimise the loss of silage by weathering, and also to avoid the effects of deterioration of the paper or similar lining material due to exposure to the weather. The outer circular wall consists of welded steel-wire mesh 10, and against the inner surface of this circular wall a band 11 of "Sisalkraft" paper is placed. Inside this lining of paper a second lining 12 is arranged also to extend completely around the interior of the silo; the



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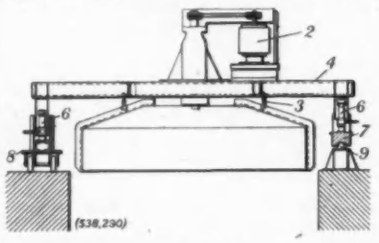
lower edges of the linings 11 and 12 are turned under to prevent ingress of air into the silo at the base. Where the amount of silage is greater than would be protected by a single band of "Sisalkraft" a third band 13 is arranged to overlap the upper edges of the band 11 between it and the wire-mesh wall. A fourth band 14 overlaps the upper inside edge of the band 12 so as to avoid the formation of a ledge on which the silage could rest. Similarly, the encircling welded mesh steel wall can be built up of three bands 10, 17 and 18 which overlap by one mesh in such a way as to avoid the formation of ledges on which the bands of lining material can catch when the silage sinks. (*Accepted July* 22, 1941.)

FURNACE APPARATUS.

538,290. Furnace - Cover Operating Mechanism. Siemens-Schuckert (Great Britain), Limited, of Brentford, and F. H. Ditschler, of Brentford. (2 *Figs.*) March 12, 1940.—The mechanism is for lifting the covers off furnaces and traversing them laterally to one side of the furnace for charging and discharging. The cover is suspended by a system of springs and rods 3 from a rectangular frame 4 which carries an electric motor 2 and a driving gear for the air-circulating fan of the furnace. The



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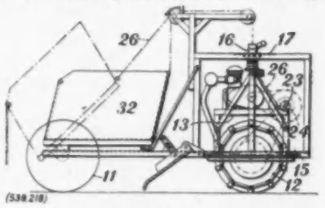
frame 4 is supported at each end on a pair of hydraulic rams 6 which raise it and the cover clear of the furnace body before being slewed to one side for charging. The rams 6 are mounted on bases 7 and 8. The base 7 incorporates a pivot 9, and the base 8 travels on wheels running on arcuate tracks. During the raising of the frame the latter is prevented from swinging about its longitudinal axis by accurately fitting guides and also by a fairly wide spacing of the rams. (*Accepted July* 28, 1941.)

MOTOR VEHICLES.

538,218. Tipping Truck. Aveling-Barford, Limited, of Grantham, and W. M. Henderson, of Glasgow. (3 *Figs.*) April 22, 1940.—The truck is of the so-called "dumper" kind. At the front end of the main frame is a pair of road wheels 11 and a tipping body 32, and at the rear end is a single steering and driving wheel 12 carried by a sub-frame 13 which carries the engine and a body-tipping winch drum 24. The sub-frame can be rotated through a full revolution in order to reverse the truck. A ring on the sub-frame located at about the level of the axle of the wheel 12 is journalled in vertically floating rollers 15 pitched circularly around the sub-frame and mounted in the rear portion of the main frame. The top of the sub-frame has a hollow vertical trunnion 16 which is journalled in a bar 17 supported



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on pillars on the main frame. A chain drive is taken from the gearbox to a countershaft 23, whence a second chain drive is taken through a clutch to the rear wheel 12. Mounted also on the countershaft 23 is the winch drum and an associated double clutch by which power can be transmitted to the rear wheel or to the winch drum. A wire rope 26 on the winch drum is led up through the bore of the trunnion 16 and over guide pulleys on an overhead beam to a hook on the rear of the tipping body 32 so that, when the rope 26 is wound in by the winch the body 32 is tipped forwards over the front end of the truck and discharged. The arrangement is such that the body 32, as it attains its maximum tipping angle, oscillates slightly so that discharge of the contents is facilitated. (*Accepted July* 24, 1941.)

MISCELLANEOUS.

536,492. Production of Polished Glass Strip. Pilkington Brothers, Limited, of Liverpool, F. B. Waldron, of Prescot, L. H. Davies and J. H. Griffin, of St. Helens. (3 *Figs.*) October 14, 1939.—In the production of flat glass, faults sometimes occur, such as portions of incompletely molten raw material, and patches of glass at a lower temperature than the general body of glass, which cause local strains. When the strip is drawn through the polishing apparatus it is much more likely to break at such a fault, and the object of the invention is to increase the strength of the strip by eliminating the local strains due to faults. The glass strip 1 passes on a roller bed from the lehr 3 to the grinding apparatus 4. A sand-blast nozzle 8 is held in a frame 9, which rests on the glass strip, the nozzle being attached temporarily to the strip by suckers. In operation, when a fault is noticed as the glass issues from the lehr, the frame 9 is laid on the glass, with the nozzle 8 directed towards the fault. The frame 9 is then attached to the glass by the suckers and travels with the strip, while the sand-blast cuts a hole through the strip.

Fig.1.

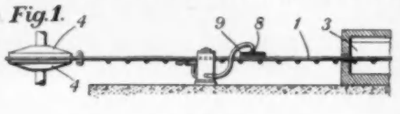
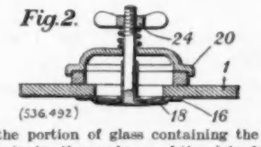


Fig.2.



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Removing the portion of glass containing the fault in this way eliminates the weakness of the strip due to the strained glass, but introduces another source of weakness in the rough edges of the hole. This source of weakness is removed by fortifying the rough surface by treatment with dilute HF fortifying solution. The device for applying the fortifying acid consists of a rubber disc 16 (Fig. 2) pressed against the underside of the glass surrounding the hole by a flexible metal disc 18. This disc is attached to a threaded rod. A metal ring 20, with rubber sealing ring, is pressed on to the upper side of the glass by the fly-nut 24. A rubber tube protects the rod from the acid. The hole can then be filled with fortifying acid above the level of the upper surface of the glass and the edges are fully fortified. Before the hole enters the grinding apparatus, it is plugged with plaster or wood, to prevent the passage of abrasive through the hole. The strip with the hole is weaker than a faultless strip, but this weakness is generally small compared with the weakness due to a fault. (*Accepted May* 16, 1941.)